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original article

Open and endovascular treatment by covered and multilayer stents in the therapy of renal artery aneurysms: mid and long term outcomes in a single center experience

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SUMMARY: **Open and endovascular treatment by covered and multilayer stents in the therapy of renal artery aneurysms: mid and long term outcomes in a single center experience.**

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Aim. *The purpose of this paper is to evaluate the mid and long terms outcomes of open and endovascular surgical treatment, as well as multilayer stent, in patients affected by Renal Artery Aneurysm (RAA).*

Patients and methods. *Twenty five patients with RAA (24 monolateral and 1 bilateral aneurysm, 26 aneurysms) were observed between 2000 and 2015: 4 were not treated due to the small size of the aneurysm (< 2.5 cm); out of the remaining, 16 underwent endovascular treatment, 2 were treated by open surgery consisting in aneurysmectomy and graft reconstruction and 5 (in 1 patient bilateral) were treated by ex vivo repair and autotransplantation.*

Results. *Out of the 22 patients treated for RAA, one patient operated upon open surgery presented an early thrombosis of a PTFE graft, followed by nephrectomy (4.7%); one patient underwent autotransplantation showed an ureteral kinking without functional consequences. In a follow-up ranging from 1 and 11 years (mean 5 years), no deaths were observed; all the renal arteries repaired were patents and 16 out of 21 patients had a significative reduction of systemic blood pressure.*

Discussion. *The choice of the best treatment is based on aneurysm's morphology according to Rundback's classification. The type I, involving the main renal artery, is always treated by endovascular approach; type II, involving renal artery bifurcations may be treated by open surgery or multilayer stents; type III (hilar or intraparenchymal aneurysms) needs only an open surgical treatment as autotransplantation.*

Conclusion. *Based on our experience it seems that most of RAAs may be treated by endovascular technique. The ex vivo autotransplantation represents the first-line treatment in hilar and intraparenchymal aneurysms. Multilayer stents seem to have good outcome in the treatment of aneurysms involving arterial bifurcations. Mid and long term results, related to kidney preservation and to normalization of blood pressure, seems satisfying.*

KEY WORDS: Renal artery aneurysm - Open surgery - Endovascular - Covered stent - Multilayer stent.

Introduction

Renal artery aneurysms (RAAs) represent a rare clinical entity, with a prevalence in the general population ranging between 0.09-0.3% (1, 2). The risk of rupture is low except in selected groups of patients such as child-bearing age women (3, 4). In some patients distal embolization from the thrombosed RAA can cause renal infarcts with hematuria and flank pain; while in other patients, hypertension is a common finding. In most cases there are no associated symptoms (5-8). According to Poutasse's classification, there are four main type of RAA: saccular, usually degenerative and resulting from the vessel wall segmental alteration; fusiform, secondary to atherosclerosis and often associated to stenotic lesions or secondary to arterial fibrodysplasia; dissecting, usually resulting from the dissection of the renal artery with subsequent dilatation and often associated with chronic dissection of the aorta; hilar or intraparenchymal, more often congenital, sometimes post-traumatic, usually involving branches of renal artery bifurcation.

The diagnosis of RAA is more often incidental and follows imaging tests like Duplex Scanning (DS) or Computed Tomography (CT) performed for other ab-

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dominal diseases. In some cases the presence of associated symptoms may facilitate the diagnosis, which nevertheless requires additional and targeted imaging examinations such as DS, CT, Magnetic Resonance (MR) or angiography.

The current criteria to treat RAA include the presence of clinical symptoms, aneurysms diameter > 2.5 cm (even if symptom free) and aneurysms > 1 cm in childbearing women. The endovascular treatment seems to have replaced traditional surgery in most cases. The choice of treatment between endovascular versus open surgery is generally based on the aneurysm morphology. Many aneurysms involving renal artery bifurcation need up to date of open surgery. The introduction of multilayer stent in clinical practice offer new prospective in these patients. The purpose of this study is to evaluate the indications for surgical or endovascular treatment and to assess mid and long-term outcomes.

Patients and methods

Between 2000 and 2015, 25 patients (16 F - 9 M) with RAAs were studied. Twenty four patients had monolateral aneurysm while 1 had a bilateral aneurysm (26 aneurysms observed). The mean age was 44.5 years (range 16 to 73). Six were asymptomatic; 19 had an uncontrolled hypertension; in 3 of these a moderate stenosis of the renal artery was present; 1 had recurrent flank pain. In all patients RAAs were detected by DS and confirmed by CT. RAA mean size was 3.0 cm (range 1.7-4.3cm).

Four patients were not treated due to the small size of the aneurysm (<2.5 cm). The remaining 21 (1 bilateral) underwent reconstruction treatment, respectively 16 by endovascular procedures and 5 (1 bilateral) by open surgery.

In the endovascular treatment arm, 7 RAAs were excluded by a covered stent (3 Advanta®, 2 Fluency®, 2 Viabhan®) (Figure 1). In all these cases a femoral approach was chosen.

In 3 of them, because of the saccular aneurysm shape, a simultaneously embolization of aneurysm's sac with metal coils was performed. In 9 cases a multilayer stent was implanted (Cardiatis®) because of the involvement of a branch of the renal artery bifurcation. This approach was advised in cases in which almost 1/3 of renal parenchyma was perfused by the arterial branch involved (Figure 2 A, B).

In the surgical treatment arm, 2 aneurysms were resected and renal artery repaired by PTFE graft in 1 case and Dacron in the other one.

Three patients with solitary RAA and 1 with bilateral RAAs underwent renal ex vivo autotransplantation (5 RAT). The latter technique consisted in kidney explantation and preservation in Belzer solution at 4°C; thereafter aneurysmectomy was performed and involved arterial branches repaired during bench surgery. In all cases the kidney was reimplanted in the iliac fossa by an end-to-side vascular anastomosis on the external iliac artery and vein. A segment of saphenous vein was always employed to repair the renal artery. In 4 cases the saphenous vein segment was sutured on a Teflon patch and then applied on the external iliac artery. The renal vein was anastomosed directly on the external iliac vein (Figure 3 A, B, C, D)

After positioning a Bracci's tutor, the ureter was modeled on the bladder and then anastomosed. In the postoperative period renal function and changes in syste-

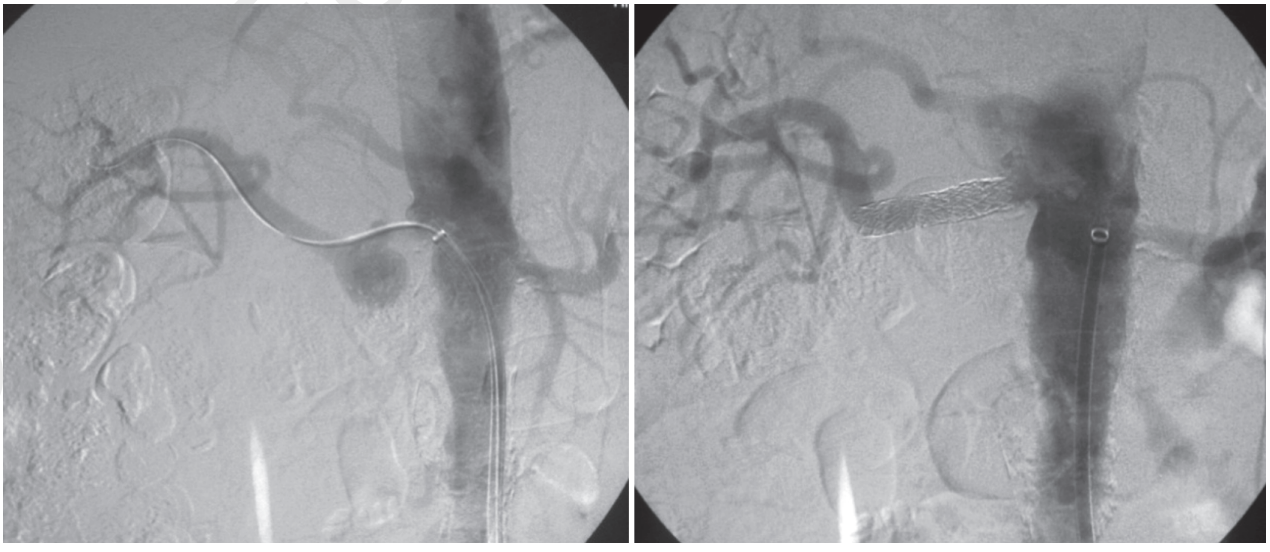

Figure 1 - Right renal artery aneurysm treated by covered stent (type I Rundback).

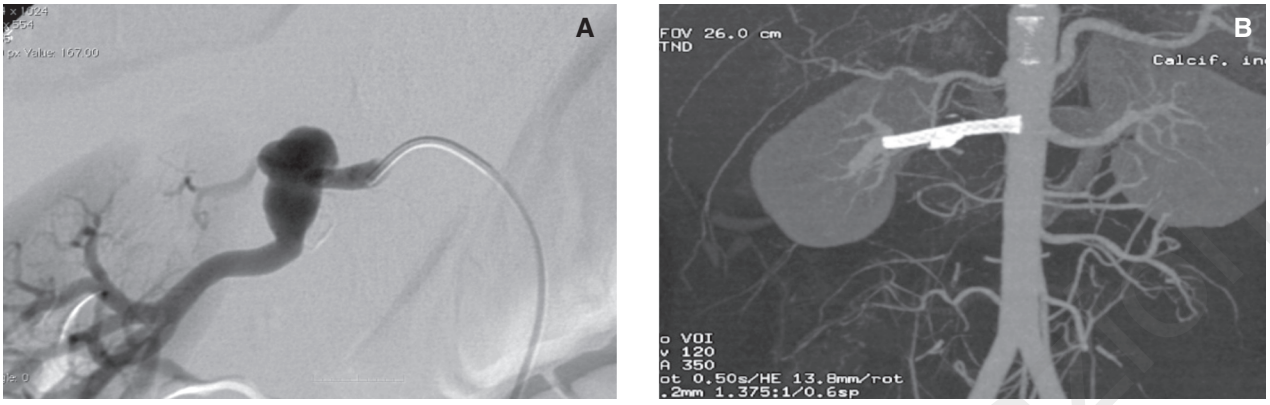

Figure 2 A, B - Right renal artery aneurysm involving a renal branch treated by multilayer stent (type II Rundback).

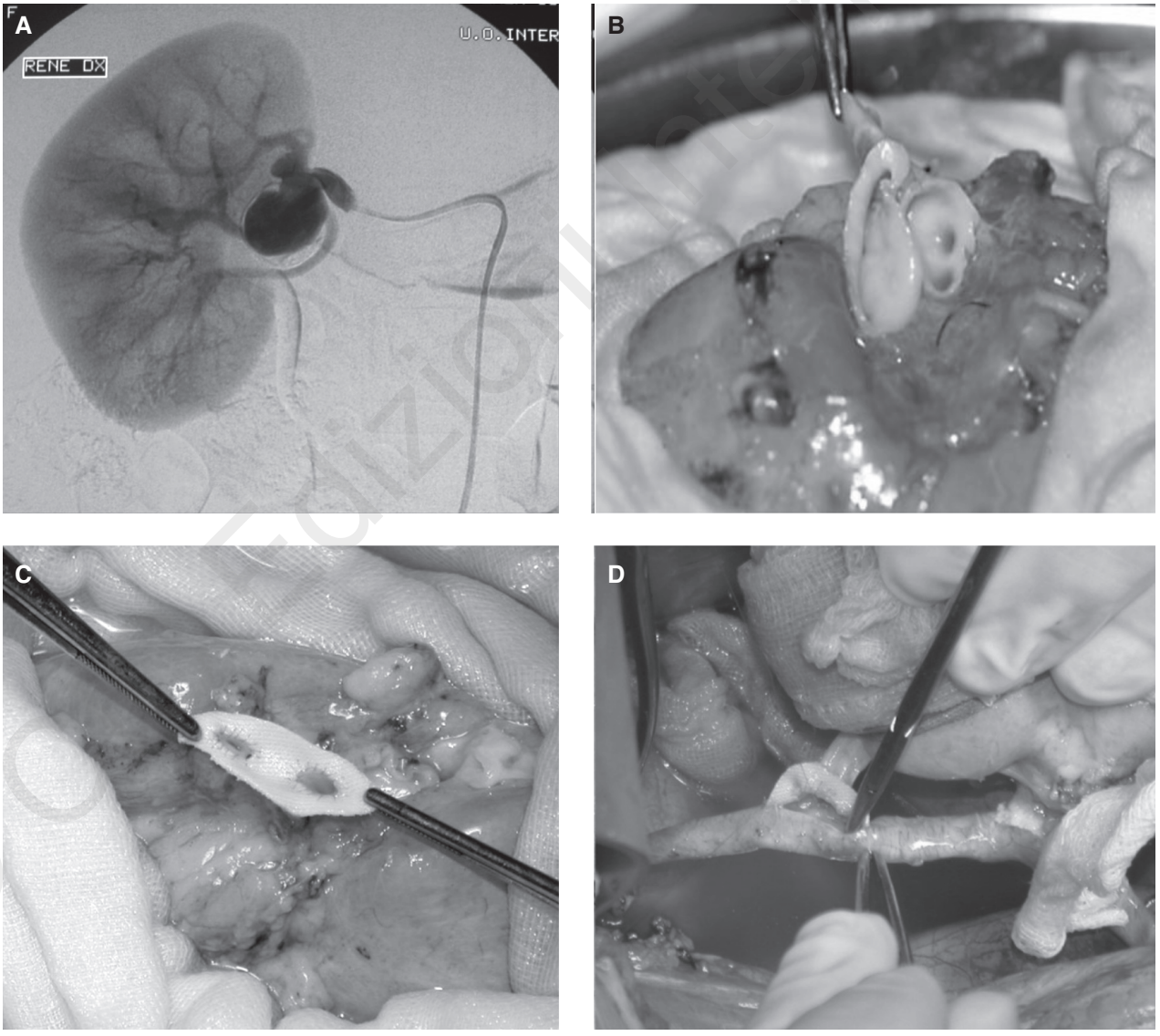

Figure 3 A, B, C, D - Right hilar renal aneurysm treated by ex vivo autotransplantation.

mic blood pressure were monitored; in 3 patients who underwent autotransplantation ex vivo, the selective diuresis of the auto transplanted kidney was also carefully monitored.

Results

No operative death was observed.

One patient undergone open surgery presented an early thrombosis of a polytetrafluoroethylene (PTFE) graft, followed by nephrectomy (4,7%%); in 1 patient operated upon RAT, an ureteral kinking without functional consequences (by means of US and urographic control) was detected. Renal function and diuresis were normal in all cases except in 2 patients undergone RAT in which, during the first postoperative day, was detected a slight increase in creatinine and a moderate decrease in selective diuresis. Both these data were normalized within a week. All patients undergone surgery were rated at 30 days after treatment with DS and renal scintigraphy showing patency of reconstructed vessels and good renal function. Particularly all the 16 stents included 9 multilayer stents were patent. In this last group the exclusion of the aneurysm was always detected and the perfusion of the kidney was complete. In 14 out of 18 remaining patients (1 had nefrectomy) with preoperative hypertension, a significant reduction in systemic blood pressure was observed (77.7%). In one case a postoperative MR was performed (Figure 4). In one patient undergone RAT, scintigraphy showed a hypoperfusion of the lower pole with preservation of renal function. All patients, except two who dropped out of controls, were regularly monitored during the follow up ranging from 1 to 11 years (mean 5 years) by ultrasound investigations and repaired vessel patency resulted always confirmed.

Figure 4 - Postoperative RM control of a left autotransplantation in iliac fossa.

Discussion

The main concerns about RAAs are largely represented by several diagnostic difficulties related to the frequent absence of clinical symptoms, the risk of aneurysm rupture and therefore by indications for treatment. Furthermore, some problems are related to the choice of best surgical approach: open surgery, endovascular exclusion and embolization or ex vivo autotransplantation. In the scientific community considerable controversy continues to surround indication and choice of treatment. Whitsell suggests a conservative approach in the most of cases and open surgery in patients with rupture or upcoming rupture, pregnancy, with or without symptoms related directly to the aneurysm (9). Conversely, Clorius supports the need for aggressive treatment regardless of symptoms or size (10). According to other authors, the surgical approach should always be chosen as well in asymptomatic patients, when the size of the aneurysm reaches or exceeds 2.5 cm and/or the wall characteristics indicate a high risk of rupture (blister, lack of thrombotic intraluminal apposition, absence of calcification, inflammatory or infectious etiology) or in presence of stenosis or associated arteriovenous fistula. Recurrent abdominal or flank pain, uncontrolled hypertension or hematuria conversely requires surgery also for small size aneurysms.

Hypertension may be the key finding to diagnose RAA; although there is no proven relationship between RAA and hypertension, the literature clearly reports that, in some circumstances, such as in case of fibromuscular dysplasia (stenosis + aneurysm), the 2 pathological conditions are closely related (11).

Moreover, cortical microembolisms by mobilization of intraluminal thrombus may be a cause of hypertension and renal failure; more rarely, large aneurysms of the hilum can modify renal hemodynamics by means of arterial compression and induce a parenchymal damage resulting in organ failure. These conditions obviously reinforce an indication for surgical treatment. In our experience in 3 patients an associated stenosis was ob-

served; the hypertension in the remaining patients was probably due to arterial compression by large aneurysms and parenchimal embolization.

For childbearing age women this indication becomes mandatory: pregnancy increases enormously the risk of rupture due to both compression exerted by uterus growth and the increased secretion of hormonal factors stimulating a more rapid grow of the aneurysm's volume.

Current surgical options are represented by: aneurysmectomy and simple repair of the artery; reconstruction by PTFE, Dacron graft or by autologous vein; segmental in situ resection and direct anastomosis; extracorporeal repair by RAT; endovascular treatment by covered or multilayer stents, associated with aneurysm's sac embolization (12, 13).

The localization and morphology of the aneurysm affects the choice of treatment: in fact, the classic truncal aneurysms are easily treated by resection and subsequent in situ reconstruction by an end-to-end anastomosis of the 2 stumps or by prosthetic replacement, preferably autologous saphenous vein or PTFE, when vein is not adequate or available.

Also in these cases endovascular approach can simplify the treatment: often anatomical features of the aneurysm allow this choice. It can be quite simple to place a coated stent, avoiding closure of collateral vessels to the kidney (14). Saccular or fusiform aneurysms located in the middle part of the artery always allow an endovascular treatment, either by covered stent to exclude the RAA or by the sac embolization with metal coils. In patients with renal artery aneurysms involving a renal bifurcation similarly is possible an endovascular technique: in some cases a little arterial branches may be occluded. In the cases in which almost 1/3 of renal parenchyma is perfused by the involved branch, a multilayer stent is advised; in our experience this approach regained optimal results in preserving renal perfusion and to obtain aneurysmal exclusion (15). On the other hand, aneurysms located at the hilum are not suitable for a less invasive approach, both for the technical difficulties and the high risk of renal ischemia or aneurysm rupture. Consequently in these circumstances a surgical treatment that gives greater guarantees of success, both in terms of mortality and morbidity that in terms of efficacy, it is certainly represented by ex vivo reconstruction of the renal artery through surgery counter. The arterial reconstruction offer best results with autologous vein grafts and the arterial iliac anastomosis can be simplified by interposition of a Teflon patch.

Replanting the kidney into the iliac fossa is certainly simpler but requires, however, to "shorten" the ureter to prevent kinking as occurred in a case of our experience.

TABLE 1 - RUNDBACK'S CLASSIFICATION FOR MANAGEMENT OF RAAS BASED ON THEIR MORPHOLOGY AND LOCATION.

Type I	**Saccular aneurysm** • Involves the main renal artery • Is always treatable with stenting
Type II	**Fusiform aneurysm** • Involves the renal bifurcation • May be fit for surgical treatment or endovascular repair in selected patients (sacrificing smaller renal branch or using a flow-diversion stenting)
Type III	**Hilar or intraparenchymal** • Avails only surgery and more frequently RAT.

The choice of open or endovascular treatment in our experience was essentially determined by the RAA anatomical site and morphology, according to Rundback's classification (16) (Table 1). Analysis of our results shows that the rate of operative complications is absolutely acceptable. Even the mid and long-term results, regarding vessel and stents patency, appear to be very satisfactory; thereafter the use of the multilayer stents allow an extension of the endovascular approach in these patients. The hypertension care offer favorable outcome in most patients affected.

Conclusion

Based on our experience and on a review of the literature, it clearly appears that RAAs can be treated with either method: endovascular or open. The choice between these two options is related to the site of the aneurysm and its morphology as well as to the involvement of the branches of the renal artery. In most cases, endovascular exclusion with covered stent appears the best solution. The introduction of multilayer stents in clinical practice allow to extend the endovascular approach and offer encouraging results. The autotransplantation is the best choice for hilar or intraparenchymal aneurysms. The results in terms of saving the kidney and clinical improvement in symptomatic cases are satisfactory even in mid and the long term follow up.

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