# A preliminary experiment utilizing "aneurysm neck remodeling technique" for management of complex wide-necked renal artery aneurysms*

*Experiência preliminar com o uso da técnica de "remodelagem de colo" para tratamento endovascular de aneurismas complexos da artéria renal*

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**Abstract** **OBJECTIVE: To report preliminary results of aneurysm neck remodeling in the management of wide-necked renal artery aneurysms. MATERIALS AND METHODS: Five patients (three women and two men between 49–72 years; mean age, 62 years) with wide-necked renal artery aneurysms measuring from 10 to 25 mm in diameter were submitted to balloon-assisted coil embolization along a three-year period. The micro-balloon was placed along the aneurysm neck and temporarily inflated for introduction of detachable microcoils into the aneurysmal sac. RESULTS: Balloon positioning and microcoil embolization were successfully completed in all of the cases with achievement of complete aneurysm occlusion without coil protrusion or parent vessel obstruction. CONCLUSION: The present preliminary experiment indicates that the "aneurysm neck remodeling" is technically feasible and effective in the management of complex renal artery aneurysms without sacrificing any arterial branch.**

*Keywords:* Aneurysms; Renal; Endovascular treatment; Remodeling technique.

**Resumo** **OBJETIVO: Relatar os resultados preliminares da aplicação da técnica de "remodelagem do colo" no tratamento dos aneurismas de colo largo da artéria renal. MATERIAIS E MÉTODOS: Cinco pacientes (três mulheres e dois homens, com idade média de 62 anos, intervalo de 49–72 anos) com aneurismas da artéria renal variando de 10 a 25 mm de diâmetro, de colo largo, foram tratados com técnicas de embolização assistidas por "remodelagem do colo" com balão durante o período de três anos. O microbalão era posicionado diante do colo do aneurisma e insuflado, temporariamente, durante a colocação das micromolas destacáveis no interior do aneurisma. RESULTADOS: O posicionamento do balão e a colocação das micromolas foram realizados com êxito em todos os casos. Oclusão completa do aneurisma, sem protrusão de micromolas ou obstrução do vaso parental, foi alcançada em todos os pacientes. CONCLUSÃO: Nossa experiência preliminar indica que a aplicação da técnica de "remodelagem do colo" no tratamento dos aneurismas de colo largo da artéria renal é tecnicamente viável e eficaz para o tratamento endovascular de aneurismas complexos da artéria renal, sem o sacrifício de qualquer ramo arterial.**

*Unitermos:* Aneurismas; Renal; Tratamento endovascular; Remodelagem.

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## INTRODUCTION

Renal artery aneurysms (RAAs) represent 22% of visceral aneurysms[1] and 1% of all aneurysms[2,3]. However, despite their low incidence, renal artery aneurysms have been diagnosed with higher frequency because of the increasing utilization of non-invasive diagnostic imaging methods. Renal artery aneurysms may be treated with conventional surgery[3–5] and with endovascular therapy, which is less invasive so that recently it has become preferable to surgery. The development of microcatheters, guide-wires and novel embolic devices that were firstly utilized in interventional neuroradiology, allows a selective embolization even in cases of complex wide-necked lesions[6]. Endovascular therapy for management of RAAs may be performed by means of balloon-catheters, liquid embolic agents, covered stents, traditional platinum microcoils or controlled-release microcoils, such as the Guglielmi detachable microcoils (GDC)[7–9]. This type of microcoils allows a precise release once its correct positioning is confirmed by arteriography.

Endovascular occlusion of lateral wall or narrow neck aneurysms with microcoils generally is not very laborious. The utilization of endoprostheses (or covered stents) also is feasible for the management of such aneurysms. However, if the aneurysm involves an arterial bifurcation, or

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even is located only few millimeters from a vascular bifurcation, such endovascular treatment modalities may place the permeability of these adjacent vascular branches at risk[10].

Currently, the aneurysm neck remodeling technique (Moret technique) or balloon-assisted embolization is a technique widely utilized in the management of intracranial wide-necked aneurysms. Such technique has considerably increased the feasibility and usefulness of the endovascular therapy in cases of more complex aneurysms.

The authors present preliminary outcomes in patients with complex wide-necked renal artery aneurysms submitted to this technique originally adopted for neurovascular applications.

## MATERIALS AND METHODS

The authors retrospectively analyze five cases of wide-necked renal artery aneurysms endovascularly treated with the neck remodeling technique by the team of Hospital Universitário Clementino Fraga Filho – Universidade Federal do Rio de Janeiro, RJ, Brazil, in the period from March/2006 to March/2009. The patients were in the age range between 49 and 72 year, and the aneurysms sizes ranged from 10 to 25 mm. During this three-year period, five wide-necked renal artery aneurysms were treated by means of balloon-assisted embolization with the neck remodeling technique. Exclusion criteria were the presence of uncorrectable coagulopathy and narrow neck aneurysm (body:neck ratio > 2).

Three of the aneurysms were initially diagnosed at computed tomography angiography and two at color Doppler ultrasonography. Detailed study of the aneurysmal neck and analysis of the origin and course of arterial branches at risk for occlusion or microcoil protrusion during embolization were reserved for digital catheter angiography. The mentioned aneurysms were considered as complex because of their location in the renal artery bi- or trifurcation, or involving the origin of segmental artery branches and, for this reason indicating a balloon- or stent-assisted procedure to protect the parent artery. In the author's institution, the balloon-assisted neck remodeling technique is generally adopted to avoid the necessity of extended platelet antiaggregation therapy.

Patients' clinical data and aneurysms' characteristics are shown on Table 1. The contralateral kidney was healthy in all of the five cases. The main indication for the treatment was the presence of difficult-to-manage hypertension in two of the patients, increase in the aneurysm size observed at follow-up in one, flank pain associated with hematuria in one, and size > 2 cm in one patient. A term of free and informed consent was signed by all the patients.

A 60 cm-long 6Fr sheath (Cook, Inc.; Bloomington, USA) was introduced by means of puncture of the right femoral artery and positioned at the origin of the renal artery of interest for digital angiography. An intravenous 5,000 U heparin bolus was performed at the beginning of the process to keep the ACT (activated coagulation time) at two-threefold higher than the basal time. . The aneurysms and parent vessels were measured with the aid of a standard software for anatomic measurements. Through the 6Fr sheath, a Hyperform 4 × 20 mm compliant balloon catheter (Figure 1) with a Silverspeed 10 microguidewire (MTI Microtherapeutics; Irvine, USA) was introduced into the main segmental artery branch and positioned along the aneurysmal neck. Through the same 6Fr sheath, a microcatheter with two radiopaque marks (SL 1018) with Transend 14 guidewire (Boston Scientific; Natick, USA) was advanced within the aneurysm, successively releasing platinum microcoils (GDC-Boston Scientific; Natick, USA) with different diameters and lengths, the first microcoil presenting a 3D shape, with a maximum size approximately similar to the aneurysm size. A road map was utilized in this phase of the procedure. Before each microcoil detachment, the balloon was deinflated to check whether there was a microcoil protrusion through the aneurysmal neck. Once each microcoil was successful positioned, the balloon was deinflated and an angiogram was performed to confirm the arterial patency. Then, control arteriography demonstrated complete aneurysm obliteration and a dense microcoils agglomerate within the aneurysm, with main renal artery and respective segmental branches permeability and normal nephrogram (Figure 2). The 6Fr sheath was drawn back and the femoral hemostasis was achieved with 6F Angio-Seal (St Jude Medical; Minnetonka, USA).

## RESULTS

Embolization with neck remodeling technique was technically successful in all of the five patients. Angiography demonstrated complete aneurysmal occlusion without microcoil protrusion into the parent vessel after the treatment completion in all of the cases, with no arterial flow compromise. None of the patients presented significant post-procedural increase in levels of nitrogen waste. Three of the patients were submitted to follow-up with computed tomography angiography within 6 to 14 months after the embolization (mean follow-up period, 10 months). The other two patients could not be reached or refused to undergo follow-up studies. At such follow-up studies, the aneurysms remained

**Table 1** Clinical and angiographic characteristics of renal artery aneurysms.

| Patient no. | Age / Sex | Largest aneurysmal diameter | Aneurysmal site | Associated conditions |
|---|---|---|---|---|
| 1 | 62 years / Female | 15 mm | Bifurcation of the left segmental branch | Arterial hypertension, atrial fibrilation |
| 2 | 71 years / Male | 10 mm | Trifurcation of the right renal artery | Flank pain |
| 3 | 49 years / Female | 20 mm | Bifurcation of the right renal artery | Fibromuscular dysplasia, arterial hypertension |
| 4 | 72 years / Male | 22 mm | Trifurcation of the left renal artery | Increase in the aneurysm size at follow-up |
| 5 | 56 years / Female | 25 mm | Bifurcation of the left segmental branch | Hematuria |

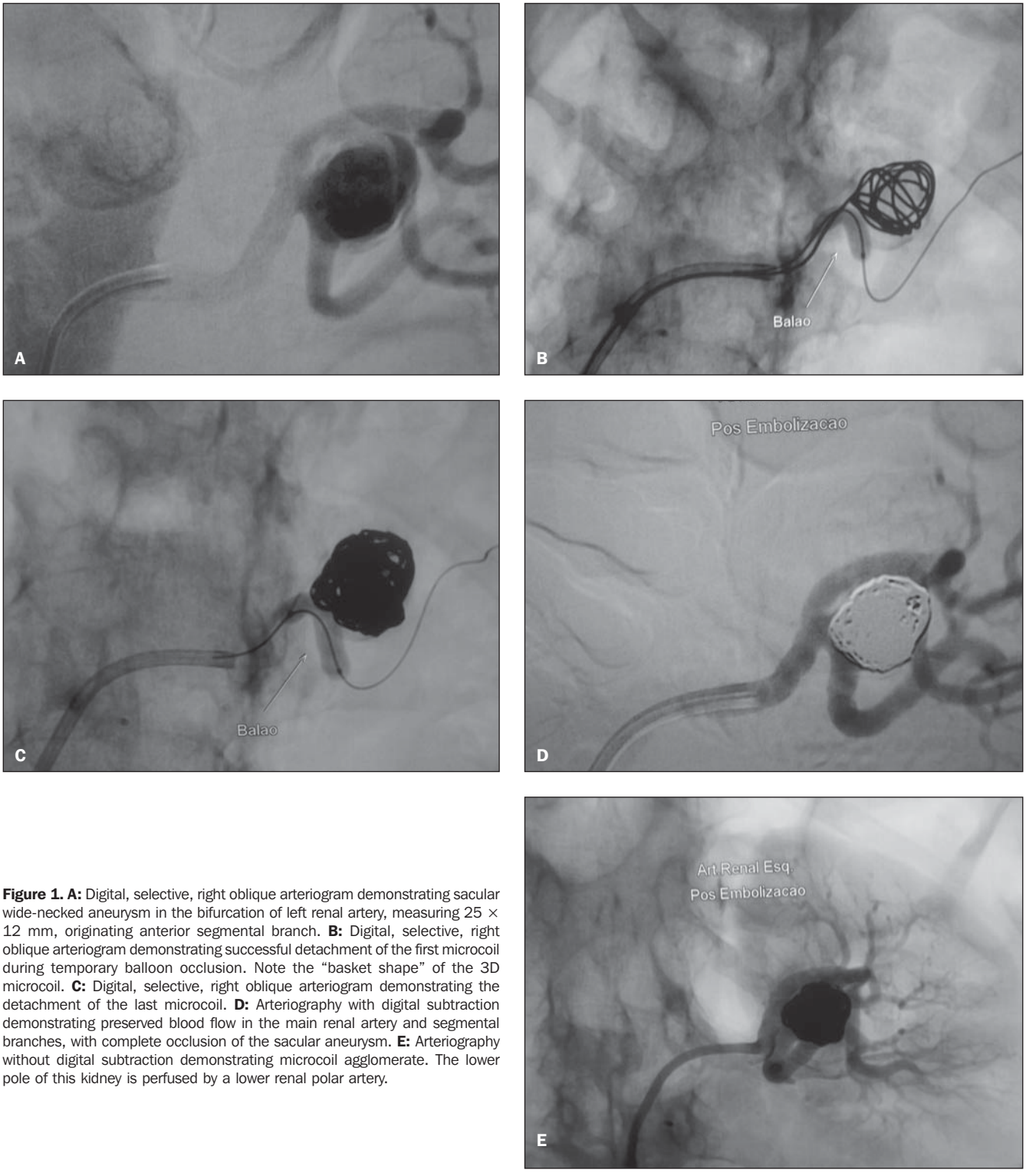


**Figure 1. A:** Digital, selective, right oblique arteriogram demonstrating sacular wide-necked aneurysm in the bifurcation of left renal artery, measuring 25 × 12 mm, originating anterior segmental branch. **B:** Digital, selective, right oblique arteriogram demonstrating successful detachment of the first microcoil during temporary balloon occlusion. Note the "basket shape" of the 3D microcoil. **C:** Digital, selective, right oblique arteriogram demonstrating the detachment of the last microcoil. **D:** Arteriography with digital subtraction demonstrating preserved blood flow in the main renal artery and segmental branches, with complete occlusion of the sacular aneurysm. **E:** Arteriography without digital subtraction demonstrating microcoil agglomerate. The lower pole of this kidney is perfused by a lower renal polar artery.

totally occluded, with no aneurysmal recanalization or microcoils compaction. At follow-up, two of the patients presented improvement in their previously observed arterial hypertension.

## DISCUSSION

Renal artery aneurysms represent one of the most common visceral aneurysms (15% to 22% of cases)[8], being found in 0.3% to 0.7% of autopsies and in up to 1% of renal arteriograms[4]. Such aneurysms are most frequently found in women. Most of them present as a non-calcified, sacular dilatation, tending to occur in the bifurcation of

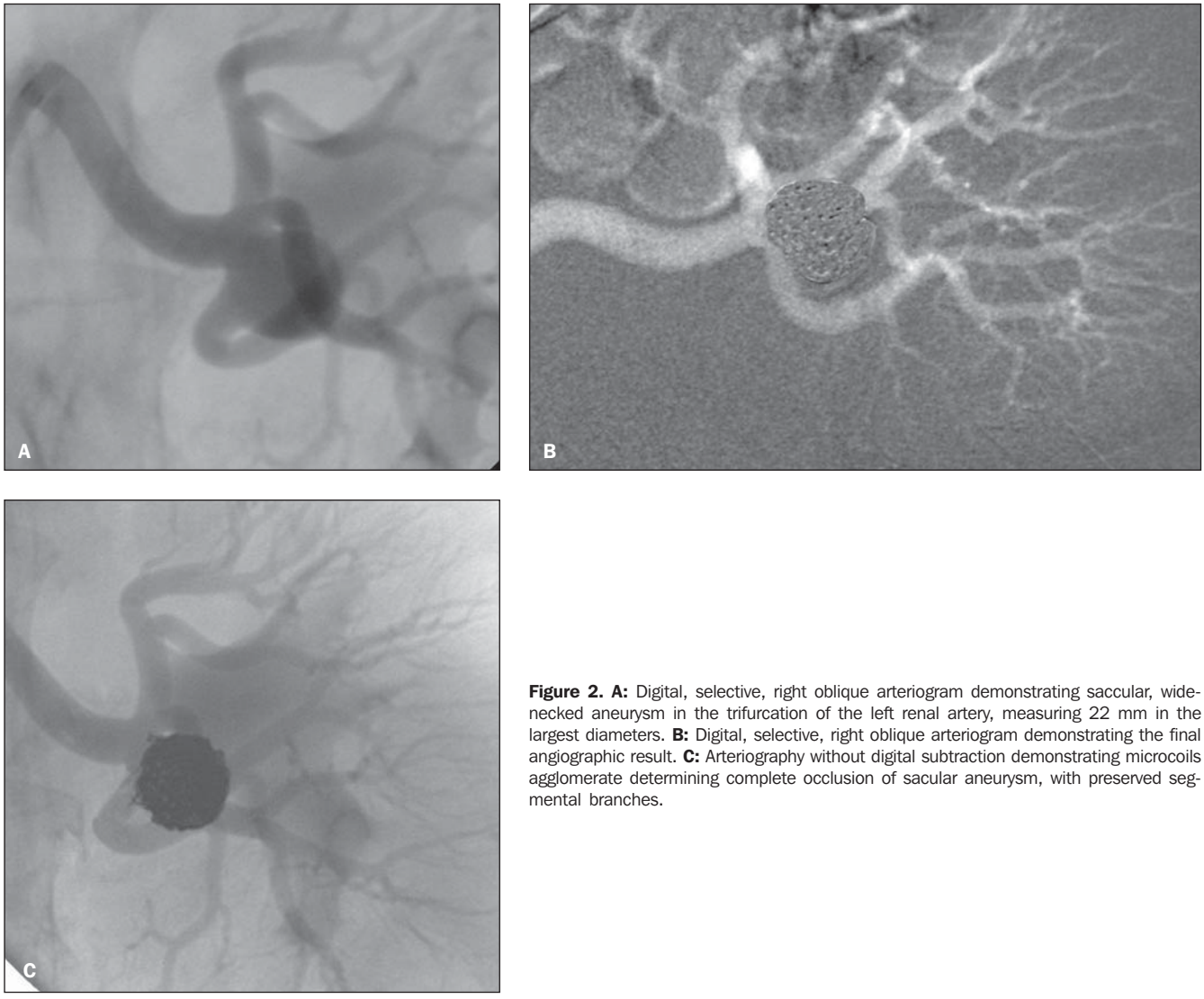


**Figure 2. A:** Digital, selective, right oblique arteriogram demonstrating saccular, wide-necked aneurysm in the trifurcation of the left renal artery, measuring 22 mm in the largest diameters. **B:** Digital, selective, right oblique arteriogram demonstrating the final angiographic result. **C:** Arteriography without digital subtraction demonstrating microcoils agglomerate determining complete occlusion of sacular aneurysm, with preserved segmental branches.

the main renal artery. The primary etiology is degenerative, with atherosclerosis and fibromuscular dysplasia being the most frequent causes. Vasculitis (for example, nodous polyarteritis)[11], trauma[12], neoplasias (for example, angiomyolipoma), mycotic and iatrogenic aneurysms (for example, post-biopsy aneurysms), besides the idiopathic ones, constitute other less frequent causes[13,14].

In most of cases, RAAs are asymptomatic, although rupture may occur with retroperitoneal hemorrhage, peripheral vessels embolization or even arterial thrombosis. The RAA is associated with renovascular hypertension in up to 73% of cases[15]. Other complications include dissection, renal infarction and arteriovenous fistula. Improvement in the arterial hypertension is a consensus in the literature[11], and hematuria resolution is described in 30% of RAAs[16,17]. The therapeutic decisions should be based, or not, on symptoms, patient's sex, hypertension severity, anticipated pregnancy, childbearing age, anatomic characteristics of the aneurysm, rupture, size, expansion and distal embolization. Fusiform type and arterial wall calcification suggest protection against rupture. While size > 2 cm is considered as the starting point for vascular treatment, rupture of aneurysms < 2 cm has been reported[18–20].

Young women, particularly those with anticipated pregnancy, are considered as patients at a higher risk for aneurysm rupture. Generally, such patients are asymptomatic, but complications such as expansion, rupture or thrombi embolism and renal infarction may occur. In some cases, these microembolisms may cause renal ischemia and consequential renovascular hypertension, although such relation still remains controversial.

Renal artery rupture occurs in less than 3% of cases, and is most frequently observed in cases of intrarenal aneurysms.

The mortality rate among pregnant women with RAA rupture is around 80%[4]. Despite the establishment of size > 2 cm as the starting point for interventional treatment, studies in the literature advocate a conservative approach[5,19]. For aneurysms with < 2 cm in size, follow-up with computed tomography or MRI is appropriate.

The management of intracranial aneurysms with detachable microcoils was firstly described in 1991 by Guglielmi et al.[21,22]. Guglielmi detachable coils (GDC) comprise a proximal teflon guidewire distally connected with a platinum microcoil with several circular memory sizes. The microcoils detachment from their guidewires occurs by means of electrolysis, as an electric current is applied, with the positive pole connected to the distal portion of the guidewire, and the negative pole (earth wire) connected to the patient.

The balloon-assisted embolization (neck remodeling technique) was firstly described by Moret et al.[18], consisting in the utilization of a microcatheter with a compliant balloon that temporarily occludes de intracranial aneurysmal neck during the placement of the microcoils, preventing their possible migration into the parent artery[16]. Klein et al.[8] have described the utilization of platinum microcoils for renal artery aneurysms, in the first published study on the dilemma in the management of a sacular, wide-necked renal artery aneurysm. By utilizing temporary balloon-assisted occlusion with the neck remodeling technique[18], the microcoils were successfully and safely positioned, functioning as a barrier against migration and as a support for their positioning, besides providing stability to the microcatheter, allowing the microcoils to most easily assume the 3D shape of the aneurysm.

Besides describing the neck remodeling technique, Abath et al.[6] have also classified the RAAs and described the best alternatives endovascular management for each aneurysm type, as follows: type I (saccular aneurysms of the main renal artery) would be best treated either with covered stent implantation or microcoils embolization; type II (aneurysms in the renal artery bifurcation), with detachable microcoils by means of the neck remodeling technique, supplemented, or not, with liquid embolic agents (Onix® or Histoacril®); and type III (aneurysms of small segmental intraparenchymatous branches), by occlusion of the parent artery with microcoils or liquid embolic agents[6].

The controlled and precise nature of the remodeling technique is already established and with proved efficacy, as reported by the medical literature approaching intracranial aneurysms. Such technique can be easily adapted for endovascular management of complex RAAs, reducing the risks for coil migration and consequential, undesirable vascular occlusion, adding safety to the endovascular treatment and yielding better clinical and angiographic results.

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