Stent-assisted detachable coil embolization of wide-necked renal artery aneurysms

Renal artery aneurysms (RAAs) are relatively rare with an estimated incidence of 0.1% in the general population, rupture incidence of about 30%, and a consequent death rate of 80% (1). The gold standard of treatment is open surgery, but it is associated with a high risk of nephrectomy, mortality, and morbidity. Less invasive endovascular therapies are becoming increasingly common for the treatment of RAAs. Here, we aimed to report three cases of wide-necked complex renal artery aneurysms treated endovascularly using stent-assisted coil embolization with self-expandable stent nitinol Solitaire AB and Concerto Axium coils. In addition, we describe the use of the waffle-cone technique in a case of wide-necked saccular RAA involving the renal artery bifurcation. Technical success was achieved in all three cases with no early or late complications and no recurrences.

Technique

Laboratory investigations including complete blood count, renal and liver function tests, electrocardiography, chest radiography, and ultrasonographic evaluation of the carotid artery, abdominal aorta, and visceral arteries were carried out prior to the procedures. All aneurysms were treated under local anesthesia using a transfemoral approach. After positioning the femoral sheath, an intravenous bolus of 5000 IU of heparin was dispensed. Stent-assisted coil embolization was performed using the Solitaire AB stent nitinol self-expandable electrolytic detachment (Covidien-EV3) and Concerto Axium coils controlled release system (Covidien-EV3). Because of its featured trait of a closed-cell stent with high radial force, Solitaire AB stent does not permit the coils’ prolapse and migration, preserving a good blood flow. On the other hand, detachable coils are repositionable, allowing an extremely precise deployment and subsequent embolization of different size aneurysms. After the procedure, the patients were monitored for 48 hours and were discharged with the administration of double antiplatelet therapy, which included acetylsalicylic acid (100 mg daily) and clopidogrel (75 mg daily) for six months. After six months, clopidogrel treatment was interrupted and only acetylsalicylic acid (100 mg daily) was maintained.

Case 1

A 64-year-old man was admitted to the outpatient clinic for evaluation of a left saccular RAA, diagnosed on CT-scan during routine follow-up of left hemicolectomy for colorectal
cancer. His past medical history was remarkable for hypertension, chronic obstructive pulmonary disease, and hypothyroidism on standard replacement treatment with levothyroxine, along with active smoking. The CT scan showed a saccular aneurysm of 23×25 mm, not involving the branches of the subsequent vascular divisions (Fig. 1a). In the operating room, abdominal aortography was followed by selective left renal arteriography with a 4 F Berenstein catheter (Boston Scientific). A 45 cm 7 F flexor sheath (Cook Medical) introducer was gently advanced intraluminally into the left renal artery. A microguidewire was then introduced distally to the aneurysm and a 6×30 mm Solitaire AB stent was advanced. Before deploying the stent, the embolization Rebar 27 reinforced microcatheter (Covidien-EV3) was navigated into the aneurysm and five Concertum Axium detachable coils were released (16 mm × 20 cm; 14 mm × 30 cm; 12 mm × 30 cm; 10 mm × 30 cm; 10 mm × 30 cm) in order to exclude the aneurysm. Once the stent was fully deployed, a completion angiogram was carried out (Fig. 1b), and complete occlusion of the aneurysm with preservation of the renal artery and its branches was established (Fig. 1c). Two days after the procedure the patient was discharged in good clinical condition, without presenting any local or general complication. One week after discharge, the patient’s serum creatinine level was unchanged. One-year postembolization, the patient remained asymptomatic with stable renal function (creatinine 0.9 mg/dL), and follow-up CT showed no signs of aneurysm recanalization or occlusion of the renal branches either proximally or distally to the aneurysm (Fig. 1d).

**Case 2**

A 79-year-old male with hypertension and hepatitis C virus-related liver disease was admitted for abdominal pain due to gallbladder stones. An abdominal CT-scan revealed a left upper pole renal artery aneurysm of 27×22 mm (Fig. 2a) with normal perfusion of the renal parenchyma (creatinine 0.84 mg/dL). After selective left renal artery angiography, we proceeded to guide catheterization with 0.014-inch Pilot (Abbott) first of the renal artery branch and then of the aneurysm itself. Next we advanced a Solitaire AB stent 6×30 mm. Before deploying the stent, the embolization Rebar 27 reinforced microcatheter was navigated into the aneurysm and four Concerto Axium coils (18 mm × 40 cm; 12 mm × 30 cm; 20 mm × 50 cm; 6 mm × 20 cm) were released in order to exclude the aneurysm. At last, the stent was fully deployed at the plan of the arterial segment over the aneurysm neck and a completion angiogram was performed, which showed the complete exclusion of the aneurysm. The patient did not have any symptoms or clinical complications. One year after the endovascular treatment, follow-up CT showed complete thrombosis of the aneurysm with preservation of renal blood flow. Blood pressure and renal function remained stable (creatinine 0.89 mg/dL), and the patient remained asymptomatic throughout the follow-up (Fig. 2b).

**Case 3**

A 40-year-old male presented with right RAA, discovered accidentally during abdomen imaging. The patient’s history was negative for common cardiovascular risk factors; laboratory findings showed normal renal function with no indications for hematuria or proteinuria. CT angiography confirmed presence of a wide-necked right renal artery bifurcation aneurysm with a diameter of 28×24 mm (Fig. 3a).

Under local anesthesia, a 55 cm 5 F flexor sheath was placed in the right common femoral artery. The right renal artery was then catheterized using a 5 F Cobra catheter and...
the sheath gently advanced over an Amplatz guidewire. Afterwards, a 6×30 mm Solitaire AB stent was implanted into the aneurysm intentionally covering the bifurcation. The stent diameter was determined based on the assessment of the size of the aneurysm neck and the diameter of the proximal parent artery. In this way, a waffle-cone was created by deploying the stent’s proximal edge in the renal artery and the distal one at the proximal extreme of the aneurysm. Such disposition avoids the migration of the coils allowing good flow in the division branches (Fig. 3b). After successful stenting, a rebar 27 microcatheter with coaxial technique was advanced into the aneurysm through the stent’s lumen for coiling. Controlled release of three Concerto Axium coils (20 mm × 50 cm; 18 mm × 40 cm; 18 mm × 50 cm) was then performed (Fig. 3c). The intra- and postoperative periods were uneventful. Imaging and laboratory examinations showed preservation of renal function (creatinine 1 mg/dL), and patient was symptom-free at six- and twelve-month follow-ups. Angiographic control at six months and CT exam at one year showed good results over the long-term (Fig. 3d).

Discussion

RAAs are rare, predominantly asymptomatic and usually detected during the work-up for hypertension or, incidentally, during abdomen imaging. Multiple etiologies of RAAs are known; most of the cases are due to fibrodysplasia, atherosclerosis, post-traumatic or mycotic origin, Ehlers-Danlos or Marfan syndrome, Takayasu or Behcet disease, and Rechlinghausen neurofibromatosis (2, 3). The natural history of RAAs is still unknown, their relationship with hypertension is controversial, and the risk of complications, particularly rupture, has led to adopting the surgical excision as routine treatment. There are still great limits in the comprehension of the true risk of rupture, but a number of different causes have been identified as possible risk factors for such complication, including morphology and histologic characteristics of the aneurysm, gender, menopausal status, and pregnancy (3, 4). Currently, the indications for endovascular arterial reconstruction include RAA size greater than 2 cm, renovascular hypertension, embolization, local pain, hematuria, and high-risk patients (women at childbearing age or patients with a single kidney). Most recent data suggest that rupture can occur in aneurysms of less than 1.5 cm in size, which brings up the question of whether smaller lesions should be treated as well (3, 5, 6). Overall, aneurysms involving one or more branches have indication for open surgery. Usually open repair requires the aneurysm excision with or without patch angioplasty; however, bypass or interposition graft can be considered as valid alternatives. Distal clamping is not a feasible option when the RAAs grow near the hilus and involve more than one arterial branch to the renal parenchyma. In that
of stent-assisted coil embolization and a
tion. This method represents an evolution
decide the endovascular transcatheter emboliza
aneurysm and was therefore treated using
bifurcation aneurysms. This method was first studied and applied
the overall technical innovation of endovas-
surgery. Despite the promising prelim-
inary results of endovascular treatment us-
ing stent-assisted coil embolization, and in
one case the waffle-cone technique, further
which demonstrates good long-term outcome.
In conclusion, stent-assisted coil embo-
ization of wide-necked renal artery aneu-
rysms is an evolutionary step in the treat-
ment of RAAs. Our experience indicates
that stent-assisted coil embolization, using
detachable coils and self-expandable stent
nitiol, is technically feasible and effec-
tive for the exclusion of challenging wide-
necked and bifurcation complex RAAs
without sacrificing any branch arteries. In
addition, our experience showed the waf-
file-cone technique is a safe, valid alterna-
tive tool for stent-assisted coil emboliza-
of complex wide-necked bifurcation aneurysms
have unfavorable anatomic features for
conventional stent assisted coil.

Case: ex-situ repair becomes a possible ap-
and it is technically feasible and effective
for open surgery. The available coil types are either pushable or detachable. Pushable coils are de-
ployed by driving them with a wire or a spe-
cific wire-pusher; detachable coils function
by controlled deployment that permits a
reposition before the coil’s release. The ma-

avoidable cases. On the other hand, they are
more expensive and present longer set-up
times. Pushable coils are often used in nar-
row-necked RAAs, while in wide-necked RAAs, given the unfavorable anatomy, the
use of detachable coils is safer: this is the
reason why we prefer the latter.

Major limitation of our study is the small
number of cases (n=3) described here. Al-
though our aim was strictly to observe the
short and mid-term results when evaluat-
ing RAAs’ exclusion by coil embolization,
no comparison was done with groups

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Conflict of interest disclosure
The authors declared no conflicts of interest.

References

Figure 4. Solitaire AB (Covidien-EV3) device. The
device must be advanced through a 0.021-inch
microcatheter. Embolic coils are placed through
the device’s interstices using a microcatheter
with a <2.5 F tip using accepted coiling
practices, taking care of having previously
selected a precise framing coil. At the end of
the procedure framing coil and stent can be
extracted.

Endovascular repair should be consid-
ered if the patient’s anatomy is favorable.
So far, there are two general endovascular
approaches: transcatheter embolization for saccular aneurysms and endovascular
stent-grafting for aneurysms that present
a sufficient distal and proximal landing
zone. Recently, the emergence of new ma-
terials and the refinement of endovascular
techniques has allowed the introduction of
stent-assisted coil embolization or the use
of multilayer flow modulator stent, extend-
ing the endovascular treatment to multiple
types of complex aneurysms (7,8). The most
severe complication is the occlusion of the
main renal artery due to coil migration.
One of our patients presented a complex
wide-necked right renal artery bifurcation
aneurysm and was therefore treated using
the endovascular transcatheter emboliza-
tion waffle-cone technique to avoid migra-
tion. This method represents an evolution
of stent-assisted coil embolization and a
vanguard approach for wide-necked bifur-
cation RAAs. In all our cases, we chose the
Solitaire AB stent, because it has a closed-
cell system, prevents protrusion of the
coils, adapts better to the anatomy of the
vessels due to its flexibility, and presents
a low percentage of restenosis. Moreover,
it can be completely retrieved even when
fully deployed for procedural control, and it
has a good radial force and kink resistance,
designed for optimal vessel conformability,
with enough resistance to coil protrusion
(Fig. 4).

The available coil types are either push-
able or detachable. Pushable coils are de-
ployed by driving them with a wire or a spe-
cific wire-pusher; detachable coils function
by controlled-deployment that permits a
reposition before the coil’s release. The ma-

advantage of detachable coils is the chance of
retrieval in case of misplacement, allowing
more precise deployment and emboliza-
for various sizes of arteries. Therefore,
they are mostly indicated in more compli-
cated cases. On the other hand, they are
more expensive and present longer set-up
times. Pushable coils are often used in nar-
row-necked RAAs, while in wide-necked RAAs, given the unfavorable anatomy, the
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Major limitation of our study is the small
number of cases (n=3) described here. Al-
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ing RAAs’ exclusion by coil embolization,
no comparison was done with groups
treated either with different types of endo-
vascular techniques or open surgery treat-
ment. Whether RAAs should be treated by
open surgery or endovascular repair is still
unclear. Devices and interventional tech-
iques that are now applied to the treat-
ment of RAAs were first studied and applied
to the cure of intracranial wide-necked aneu-
rysms. With such background consider-
ation, neurointerventional procedures and
techniques can significantly contribute to
the overall technical innovation of endovas-
cular surgery.