Packing Density Considerations for True Visceral Aneurysms

Case reports demonstrating techniques to ensure adequate aneurysm packing.

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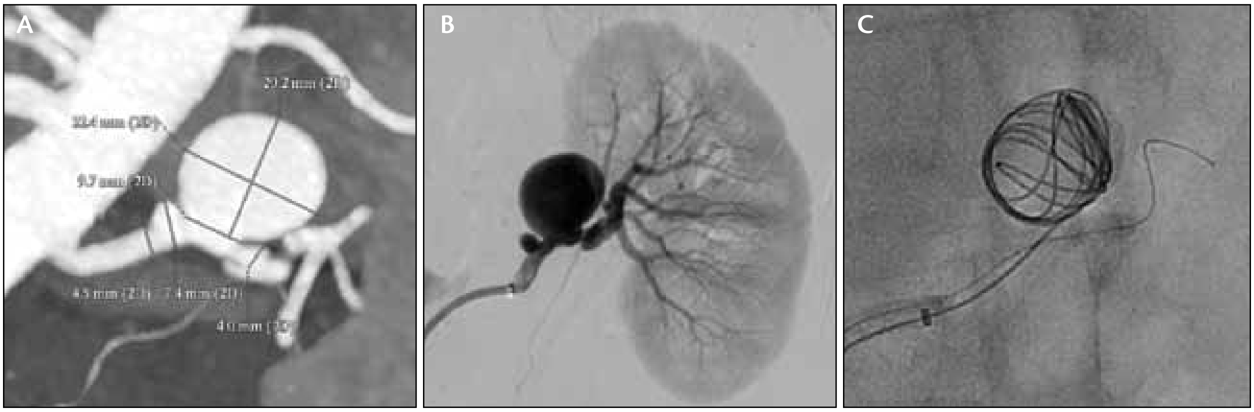
Visceral aneurysms (VAs) occur at various locations due to diverse etiologies such as arteriosclerosis, fibromuscular dysplasia, and collagen disorders. True VAs are increasingly found incidentally due to routine use of computed tomography and magnetic resonance imaging, and treatment decisions have historically been based on the size or underlying conditions. Typically, surgery or endovascular management is considered for VAs > 2 cm in diameter or for those growing in size over time. Treatment is also considered for VAs in women of childbearing age, pregnant women, and liver transplant recipients.[1] Embolization is the mainstay treatment of VAs, and coil packing is mainly indicated for narrow-neck saccular aneurysms, especially when the parent artery should be preserved to avoid distal organ ischemia.

Despite recent advances in embolization techniques, late coil compaction and recanalization can occur in inadequately packed aneurysms. In cases of cerebral aneurysms, the aneurysm size and packing density have been proven factors for long-term outcomes. In a large case series study, aneurysms with a packing density > 24% did not experience compaction at 6-month angiographic follow-up.[2] In contrast, little is known about the long-term outcomes and the optimal packing density for packing VAs. Therefore, our four affiliated hospitals in Osaka performed a retrospective survey of 46 VAs (16 splenic, 11 pancreatoduodenal, eight renal, six hepatic, and five others) in 42 patients to assess the relationship between the packing density and the incidence of coil compaction or recanalization.[3] All were unruptured true aneurysms packed with only bare platinum detachable coils. Cases treated with fibered or hydrogel coils were excluded from the study, because these coils not only influence the estimation of packing density but also may differ in the incidence of recanalization compared with bare coils. The mean follow-up period was 37 months. The mean aneurysm size was 19 mm (range, 5–40 mm), and the mean packing density was 19% (range, 5%–42%). Coil compaction and recanalization occurred in two (4%) and 12 aneurysms (26%), respectively. The mean packing density was significantly lower (12% vs 22%; $P = .00014$) and mean aneurysm size was significantly larger (22 mm vs 18 mm; $P = .0049$) in aneurysms with compaction or recanalization than in unaffected aneurysms. Aneurysms ≥ 20 mm showed significantly lower packing density than those < 20 mm (15% vs 22%; $P = .0045$). No compaction or



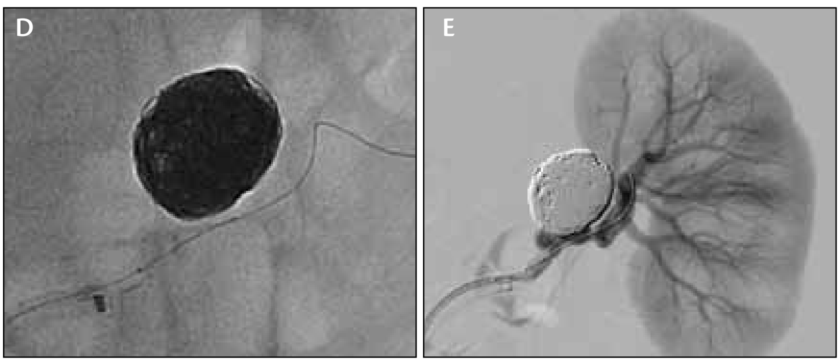


Figure 1. Measurement of the aneurysm and the parent artery size on 3D-CTA (A). Angiography shows the aneurysms and irregularity of the renal artery (B). The first framing coil was deployed under balloon protection (C). Tight packing of the aneurysm was achieved (D). The final angiogram demonstrates exclusion of the aneurysm, while preserving the renal artery (E).

recanalization occurred in aneurysms packed with a packing density ≥ 24%. These results suggest that there are certain reperfusion risks after coil packing of VAs ≥ 20 mm, which is the common size indication for embolization, and a packing density ≥ 24% could be the procedure endpoint.

TECHNICAL CONSIDERATIONS

There are several technical considerations in achieving adequate packing of VAs. First, it is essential to assess precisely the aneurysm size, morphology, and related anatomy using 3D-CT or 3D-rotational angiography. Accordingly, the optimal projection, microcatheter positioning, and the appropriate coils can be planned. Detachable microcoils are basically used in each process of framing, filling, and finishing because of their controllability and retrievability. A wide variety of 3D- or 2D-coil configurations and sizes are currently available. If only 0.015-inch GDC-18 bare coils (Stryker Neurovascular) are used, for example, approximately 800 cm and 3,000 cm of calculated coil lengths are needed to meet 24% packing density for 20- and 30-mm aneurysms, respectively. Therefore, denser or longer new-generation coils will help to reduce the number of coils necessary and thereby reduce the procedure time and radiation exposure. Particularly, the 0.020-inch Ruby coils (Penumbra Inc.) and the Azur-018 hydrogel coils (Terumo Interventional Systems) equivalent to 0.032-inch when hydrogel fully expands, can occupy a larger volume compared with conventional bare coils. Large wide-neck aneurysms may require balloon or stent-assist techniques to support the coils around the neck and protect the parent artery. The use of two microcatheters differently positioned in the aneurysm for coil delivery is also useful to create a stable coil frame. When a very wide-neck aneurysm encompasses the parent artery > 180º, a “down-the-barrel” view tangential to the parent artery may help to differentiate the parent artery lumen from coil loops around the aneurysm neck. Last, throughout the procedure, real-time calculation of the packing density is necessary to estimate the procedure endpoint. The following two cases demonstrate examples of packing VAs using these techniques.

CASE STUDY 1

A 76-year-old man was incidentally found to have a renal artery aneurysm. Three-dimensional CT angiography revealed a 22- X 20- X 16-mm saccular aneurysm in the left renal artery (Figure 1A and 1B). There was also a small aneurysm proximally. We decided to perform the coil packing for the larger aneurysm that was > 2 cm in size.

Figure 2. Measurement of the aneurysm size on 3D-CTA (A). Angiography shows a large wide-neck aneurysm of the proximal gastroduodenal artery (GDA) (B). After embolization of the right gastric artery and the distal GDA, the first framing coil was deployed in the aneurysm (C). The aneurysm was packed as tightly as possible (D).

Procedure Description

Two 6-F renal-curve guiding catheters were placed in the left renal artery by bilateral femoral approaches. From the right access, a 0.027-inch inner diameter microcatheter was coaxially advanced into the aneurysm for coil delivery. From the left access, a 4-mm X 15-mm Hyperglide occlusion balloon catheter (Covidien) was placed for aneurysm neck protection (Figure 1C). A total of eight Ruby coils (22 mm X 60 cm, three; 20 mm X 60 cm, two; 16 mm X 60 cm, two; and 14 mm X 50 cm, one) were used to make a dense coil frame. Subsequently, seven Azur-018 hydrogel coils (10 mm X 20 cm, four; 8 mm X 20 cm, two; and 4 mm X 20 cm, one) were used for filling inside (Figure 1D). The estimated packing density reached 45.5%, if the full expansion of hydrogel was considered (Figure 1E).

CASE STUDY 2

A 59-year-old woman was incidentally found to have a large GDA aneurysm. Three-dimensional CTA images revealed a 24- X 22- X 19-mm saccular aneurysm near the origin of the GDA (Figure 2A and 2B). Because the aneurysm encompassed the whole parent artery without a proximal vessel segment to occlude, we decided to perform packing of the aneurysm after the distal GDA occlusion.

Procedure Description

A 4-F shepherd-hook catheter was placed in the celiac artery via the femoral approach. First, the right gastric artery arising near the aneurysm neck and the distal GDA were embolized using pushable fibered microcoils (Tornado, Hilal, and MicroNester; Cook Medical) (Figure 2C). Through a 0.027-inch inner diameter microcatheter, 10 Ruby standard coils (24 mm X 57 cm, two; 22 mm X 60 cm, two; 20 mm X 60 cm, two; 18 mm X 57 cm, two; and 15 mm X 57 cm, two) were then used for framing, and six Ruby soft coils (10 mm X 30 cm, two; 6 mm X 15 cm, one; 5 mm X 13 cm, one; 5 mm X 9 cm, one; and 6 mm X 10 cm, one) and three Ruby extra-soft coils (4 mm X 8 cm, one; and 3 mm X 6 cm, two) were used for filling inside the frame. The estimated packing density was 27.4% (Figure 2D).

CONCLUSION

Tight coil packing of saccular VAs, preferably with packing density at least 24%, is essential to avoid late coil compaction or recanalization. Precise measurement of three-dimensional aneurysm size and intraprocedural calculation of packing density are important to achieve adequate coil packing. The use of denser coils and adjunctive neck remodeling techniques should be considered especially in patients with large and wide-neck aneurysms. ■

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