Case Report

A Loose-packing Approach for Coil Embolization of Giant Intracranial Aneurysm

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Endoluminal occlusion of giant intracranial aneurysms with coil embolization is a viable endovascular treatment option alternative to surgical clipping. However, due to the relatively large aneurysm size, the use of embolization coils for giant aneurysms could be great. A loose-packing embolization strategy in which the fundus of the aneurysm is loosely packed while the aneurysm base is tightly packed is presented. Such a coiling strategy is best suited to giant aneurysms of elongated configuration and narrow neck as illustrated in the present case. While the use of the loose-packing approach is recommended for elongated aneurysms with a narrow neck, its use is not to be generalized for aneurysms of other configurations. [*Asian J Surg* 2007;30(4):298–301]

Key Words: endovascular coil embolization, giant intracranial aneurysm

Introduction

Endoluminal occlusion of giant intracranial aneurysms with coil embolization is a viable alternative endovascular treatment option to surgical clipping. However, due to the relatively large aneurysm size, the cost of coil embolization for giant aneurysms could be great. In the present case of a giant aneurysm with tear-drop shape and narrow base, a loose-packing embolization strategy in which the fundus of the aneurysm is loosely packed while the aneurysm base is tightly packed is presented.

Case report

A 56-year-old woman, who presented with left optic atrophy and almost complete blindness, was found to have a 2 × 1 cm sized cerebral aneurysm at the left supraclinoid region on computed tomography (CT). Follow-up CT scan at 22 months showed the presence of a markedly enlarged aneurysm measuring 4 × 3.6 × 3 cm, which consisted of a think mural thrombus and projected over the left supraclinoid and frontal region. Digital subtraction angiography (DSA) showed the presence of a large aneurysm at the supraclinoid segment of the left internal carotid artery. The aneurysm as depicted on DSA had a smooth regular outline representing the inner surface of the mural thrombus. The aneurysm had a broad fundus, a conical body, and a narrow base, with a configuration simulating the shape of a tear drop (Figure A). It had a broad fundus with the greatest dimension measuring 1.4 cm, a long axis of length 2.1 cm, and a narrow base of width 2.6 mm. The dimensions of the aneurysm as measured on reconstructed images of three-dimensional radiographic angiography (3DRA) were 1.4 cm wide at the fundus, 2.1 cm long, and 2.6 mm wide at the base. In view of the deep location of the base of the aneurysm below the anterior clinoid process and the presence of a narrow aneurysm base, endovascular embolization was the elected treatment option as

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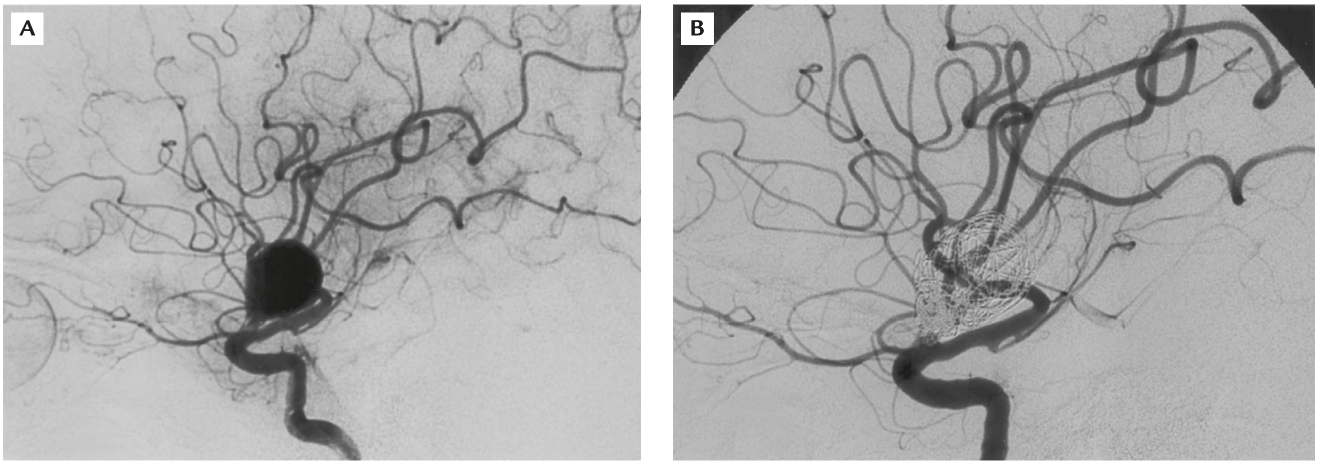

Figure. (A) Lateral view of pre-embolization digital subtraction angiography (DSA) shows the supraclinoid aneurysm. (B) Lateral view of post-embolization DSA shows complete occlusion of the aneurysm. Note the loose packing of the initial coil basket at the fundus of the aneurysm and dense packing of the base of the aneurysm.

determined jointly by a neurosurgeon and an interventional neuroradiologist.

The embolization procedure was performed under general anaesthesia with a biplane DSA (Philips BV 5000; Philips Medical Systems, Eindhoven, The Netherlands). The aneurysm was catheterized with a microcatheter (Excelsia 1018; Target Therapeutics, Boston Scientific Corp., Fremont, CA, USA), with the assistance of a microguidewire (Transend Floppy; Target Therapeutics, Boston Scientific Corp.) and a 6-Fr guiding catheter placed at the upper cervical internal carotid artery (Fas-guide; Target Therapeutics, Boston Scientific Corp.). Coil embolization started with the creation of a coil basket at the fundus of the aneurysm using three Matrix ExFirm 2D 16 mm × 30 cm coils (Target Therapeutics, Boston Scientific Corp.). A second coil basket was then created immediately inferior to the first basket to bridge the gap between the first basket at the fundus and the base of the aneurysm, using one Matrix Standard 2D 8 mm × 30 cm coil, and one Matrix Soft SR 2D 6 mm × 20 cm coil. Further coiling was performed with the aim of achieving tight packing of the base of the aneurysm within and around the second coil basket using one Matrix Standard 3D 4 mm × 6 cm coil, three Matrix Soft SR 2D 5 mm × 15 cm coils, and one Matrix Ultrasoft SR 4 mm × 8 cm coil until the aneurysm base was totally occluded. Post-embolization DSA and 3DRA confirmed total occlusion of the aneurysm (Figure B).

Follow-up CT at 5 months showed regression of the overall size of the aneurysm to 3.2 cm at its greatest dimension. However, a recurrent cavity at the base of the aneurysm was depicted on follow-up DSA at 6 months. The recurrent cavity at the aneurysm base measured 8.8 mm (anteroposterior) × 6.4 mm (transverse) × 4 mm (height), with a configuration significantly broader than the original conical shape of the aneurysm base prior to embolization. A repeat coil embolization procedure was performed at 6 months with total occlusion of the recurrent cavity achieved using one 360 GDC 10 SR 9 mm × 30 cm coil, one Matrix Standard SR 2D 7 mm × 30 cm coil, one Matrix Soft SR 2D 6 mm × 20 cm coil, one 360 GDC 10 SR 5 mm × 15 cm coil, one Matrix Soft SR 2D 4 mm × 10 cm coil, and one GDC Ultrasoft 2 mm × 4 cm coil. A second follow-up DSA at 12 months from first treatment revealed no evidence of recurrence of the aneurysm cavity. The visual status of the patient improved after the embolization procedure.

The volume of the whole coil mass immediately after the first and second embolization, defined as the volume outlined by the outermost surface of the mass of embolization coils, was calculated from the 3DRA volumetric dataset and found to be 2,197.99 mm^3 and 2,514.59 mm^3, respectively. The volume of the initial coil basket and the volume of the rest of the coiled aneurysm of the first treatment were calculated from the 3DRA volumetric dataset, and found to be 1,968.96 mm^3 and 229.03 mm^3, respectively. The volume of solid coil within the aneurysm was calculated from the summation of the volume of each individual coil used in the aneurysm. The volume of each individual coil was calculated from the product of the cross-sectional area of each specific type of coil and the length of the coil. The cross-sectional area of each specific type of coil was calculated from the diameter of the coil as provided by the manufacturer. Accordingly, the volume of solid coil within the initial coil basket in the first treatment, within the rest of the aneurysm in the first treatment, and within the whole aneurysm immediately after the first and second treatments was calculated and found to be 99.89 mm^3, 99.60 mm^3, 199.49 mm^3, and 277.81 mm^3, respectively. The coil-packing density, defined as the ratio of the volume of coils to the volume of the coiled part of the aneurysm, was calculated for the initial coil basket in the first treatment, the rest of the aneurysm in the first treatment, and for the whole aneurysm after the first and second treatments, and found to be 5.07%, 43.49%, 9.07% and 11.05%, respectively.

Discussion

Endovascular coil embolization of intracranial aneurysms has been conventionally performed with the aim of filling up the aneurysm lumen with as many embolization coils as possible in order to achieve total occlusion of the aneurysm and to prevent recurrence of an aneurysm cavity. It is known that recurrence of an aneurysm cavity occurs in about 25% of intracranial aneurysms.[1,2] Coil compaction as a result of the water-hammer effect of pulsatile blood flow is an important factor in the recurrence of an aneurysm cavity,[3–5] and a packing density by percentage of the coil volume to aneurysm volume of 24% or more is less likely to result in coil compaction in 6 months.[3] However, when it comes to coiling of a giant aneurysm, such a dense-packing approach requires the use of a large amount of coils and results in a dense metallic mass staying within the cranium. The loose-packing embolization approach, as illustrated in the present case, represents an attempt to explore an alternative concept of coil embolization in which the density of the embolization coil mass is reduced while still achieving total occlusion of the aneurysm, by loose-packing of the fundus and dense-packing of the neck. While dense-packing in the neck region is still considered a crucial factor for success of coil embolization and remains a goal in the loose-packing approach, dense packing at the fundus is not considered essential provided that dense-packing at the neck is achieved.

A prerequisite of such a loose-packing embolization approach is that the aneurysm base has to be narrow, preferably of an inverted funnel shape, so that tight packing of embolization coils at the base is feasible. An ideal aneurysm configuration in which the advantage of such a loose-packing approach could be maximized is that of a tear-drop configuration as illustrated in the present case. Within the tear drop, large-sized coils are employed for construction of the initial coil basket to occupy the broad fundus. The initial coil basket is not densely packed but it needs to be strong enough to support tight packing at the aneurysm base, and effectively converts the giant aneurysm into a small aneurysm for the purpose of coiling.

In the present case, the calculated packing density of embolization coils at the fundus (5.07%) was significantly lower than that at the other part of the aneurysm (43.49%), confirming loose packing at the fundus. The average packing density of the whole aneurysm immediately after the first embolization procedure was 9.07%, much lower than the range of packing density that is commonly encountered in a normally tightly packed aneurysm.

Although a recurrent cavity at the base of the aneurysm occurred in the present case, it did not necessarily indicate inadequate occlusion of the aneurysm or failure of the loose-packing approach, since aneurysms located at the ophthalmic segment of the internal carotid artery are known to be more prone to post-embolization recurrence of an aneurysm cavity.[6,7] On the follow-up DSA at 6 months, a layer of coil-free substance, likely to represent an organized thrombus, was noted to separate the recurrent cavity from the coil mass. The fact that the recurrent cavity at the aneurysm base had a significantly broader configuration than the original conical shape of the aneurysm base prior to embolization indicated that the cavity recurrence was more likely to be due to re-growth of the aneurysm cavity rather than recanalization of the coiled aneurysm or coil impaction. The fact that there was an increase in the volume of the coil mass, which was defined as the volume outlined by the outermost surface of the mass of embolization coils, from 2,197.99 mm^3 after the first treatment to 2,514.59 mm^3 after the second treatment, was further evidence that the recurrent cavity was at least partly a cavity additional to the initial aneurysm cavity and not entirely a recanalized cavity of the initial aneurysm. These observations showed that loose-packing of the aneurysm in the present case did not lead to significant recanalization of the coiled aneurysm or coil impaction.

After the second embolization procedure, the average packing density of the aneurysm was 11.05%, still significantly lower than that of a normally packed aneurysm, indicating that the overall consumption of embolization coils in a successfully embolized giant aneurysm could indeed be much reduced with the deployment of a loose-packing approach, and that a loose-packing state could be maintained despite having a repeat embolization procedure. A loose-packing approach was successful in achieving total occlusion of the aneurysm in this case. The clinical outcome of improved visual status suggested that the use of the loose-packing approach in this patient may have an added value in reducing the chance of a pressure effect due to a dense coil mass.

This case shows that a loose-packing embolization strategy is viable. While the use of a loose-packing approach is recommended for elongated aneurysms with a narrow neck, its use is not to be generalized for aneurysms of other configurations.

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