



UPDATE IN RADIOLOGY

## Assisted techniques for the endovascular treatment of complex or atypical cerebral aneurysms<sup>☆</sup>

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**Abstract** In the last ten years, the endovascular approach to the management of cerebral aneurysms has gone from being an alternative to surgery to being the first-choice technique in the vast majority of cases. The continuous development of new assisted techniques and of new materials for embolization has multiplied its therapeutic possibilities, so that safe and efficacious endovascular treatment is now possible for aneurysms that would have required surgery only a few years ago. These continuous technological advances require the professionals who treat patients with cerebral aneurysms to achieve a high degree of specialization and to keep up to date through continuous training. In this article, we review some of the most widely used assisted techniques in the endovascular treatment of cerebral aneurysms, discussing their main indications, their advantages over conventional embolization techniques, and their possible limitations.

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### Técnicas asistidas para el tratamiento endovascular de aneurismas cerebrales complejos o atípicos

**Resumen** A lo largo de los últimos 10 años, el abordaje endovascular de los aneurismas cerebrales ha pasado de ser una alternativa a la cirugía a convertirse en la terapia de elección en la inmensa mayoría de los casos. El constante desarrollo de técnicas asistidas y de nuevos materiales de embolización ha multiplicado sus posibilidades terapéuticas, de modo que en la actualidad es posible tratar con eficacia y seguridad aneurismas que hace tan solo unos años hubiesen sido considerados quirúrgicos. Este continuo avance tecnológico exige a los profesionales implicados en el tratamiento de pacientes con aneurismas cerebrales un alto grado de especialización y una actualización formativa permanente. En el presente trabajo repasamos algunas de las técnicas asistidas más empleadas en la actualidad para el tratamiento

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endovascular de los aneurismas cerebrales, mostramos sus principales indicaciones, las mejoras que suponen respecto a las técnicas de embolización convencional y sus posibles limitaciones. © 2011 SERAM. Publicado por Elsevier España, S.L. Todos los derechos reservados.

## Introduction

The management of patients with cerebral aneurysm has undergone a radical change throughout the last decade. Since the publication of the ISAT (International Subarachnoid Aneurysm Trial)<sup>1</sup> in 2002 and of the ISUIA (International Study of Unruptured Intracranial Aneurysms)<sup>2</sup> in 2003, the neurosurgical treatment has gradually been replaced by the endovascular approach as the first-choice technique for ruptured aneurysms and for a large proportion of incidental aneurysms.

The increasingly widespread use of this therapeutic modality not only has enabled operators to gain experience and improve their skills, but it has also promoted the development of new techniques and materials. These advances have made the classical indications to become obsolete, allowing the treatment of increasingly complex and atypical aneurysms in a safe and effective way.

Assisted techniques for the treatment of patients with cerebral aneurysms can be used in addition to or as alternative to conventional embolization. Much of the effort used to develop these techniques has been aimed at achieving stable closures and recanalization rates close to those of surgery, because the main advantage of neurosurgical treatment over endovascular treatment is a lower recanalization rate in the long term, resulting in a reduced need for repeat surgery and lower risk of rebleeding.

The objective of this article is to review some of the main assisted techniques for the endovascular treatment of cerebral aneurysms, discussing their main indications, their advantages over conventional embolization techniques, and their possible limitations.

## Remodeling techniques

One of the major factors limiting the endovascular treatment of cerebral aneurysms is the neck width.<sup>3</sup> Wide-necked aneurysms (>4 mm) or with a dome-to-neck ratio less than 1:2 can only be treated endovascularly if assisted techniques are employed. The reason for this lies in the morphological characteristics of these aneurysms, which highly increase the risk of coil migration or protrusion into the parent artery.<sup>4</sup>

The remodeling technique, also known as ‘‘balloon-assisted embolization’’, was one of the first techniques introduced in the routine practice for the treatment of wide-necked aneurysms or aneurysms with unfavorable morphology.<sup>3</sup> This technique involves the placement of a balloon-catheter in the neck of the aneurysm that is inflated temporarily during coil deployment (Fig. 1). At the end of the procedure, the balloon is removed and no device is left in place in the parent vessel, unless stent placement is subsequently performed.<sup>5</sup>

In addition, to avoid coil protrusion into the parent vessel, the remodeling technique has further advantages: the

balloon provides an excellent control of the neck, increases endosaccular stabilization of the microcatheter, and permits a denser packing of the aneurysm. Another advantage is that the inflated balloon inside the parent artery will help control the bleeding in the event of aneurysmal rupture during the procedure.

As a result of the development of ever more sophisticated balloons, the remodeling technique has gradually been improved, to such an extent that many centers currently use it on a routine basis.<sup>6</sup> In addition, the launch of compliant balloons, able to protrude into the aneurysm sac and to conform to the anatomy of arterial bifurcations, has broadened the indications of the technique to also include the treatment of distal aneurysms and bifurcations.<sup>7,8</sup>

The safety of remodeling has been a subject of much controversy<sup>9-11</sup> because this technique is supposedly associated with a higher risk of thromboembolism and arterial rupture or dissection secondary to the simultaneous use of multiple devices, balloon inflation, and temporary parent artery occlusion. A critical review of the recently published literature<sup>5</sup> has analyzed the outcomes of remodeling in different series of patients with cerebral aneurysms who received endovascular treatment, including the multicentre and prospective ATENA (incidental aneurysms)<sup>12</sup> and CLARITY (ruptured aneurysms)<sup>13</sup> series. The review concluded that the rate of complications, morbidity and mortality associated with remodeling is similar to that of conventional embolization. The review also provided evidence of the superiority of remodeling in terms of anatomic outcomes and degree of aneurysm occlusion in the immediate post-operative period. Based on these results, and considering the lack of randomized studies that assess the efficacy and safety of remodeling, the authors of the review advocate for the routine use of this technique.

A variant of the remodeling technique is the double-balloon remodeling, involving the simultaneous use of two balloons that are placed in each side branch of the bifurcation or in an X-shaped configuration (Fig. 2). Double-balloon remodeling provides a better sealing of the neck and better side-branch protection than inflation of one single compliant balloon, especially in wide-necked aneurysms and bifurcations.<sup>14,15</sup> However, double-balloon remodeling is not without its risks, since the simultaneous use of three microcatheters increases the technical complexity of the procedure and the risk of thromboembolic complications.

## Combined use of coils and stents

The combined use of coils and stents is another alternative for the treatment of wide-necked aneurysms or aneurysms with a dome-to-neck ratio less than 1:2.

In complex aneurysms with unfavorable anatomy, the remodeling balloon may be insufficient to prevent coil protrusion into the parent vessel and to ensure an adequate arterial reconstruction and packing of the aneurysm sac.

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