

## Surgery for high-grade unruptured brain arteriovenous malformations: era for a new paradox?

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We read with great interest the article entitled “Microsurgical resection of Spetzler–Martin grades 1 and 2 unruptured brain arteriovenous malformations results in lower long-term morbidity and loss of quality-adjusted life-years (QALY) than conservative management—results of a single group series” by Steiger et al. [8] in the July 2015 issue of this journal. The authors analyzed a surgical series of 69 patients with a Spetzler–Martin (SM) grade 1–2, 22 SM grade 3, and six SM grade 4 unruptured brain AVM in terms of postoperative morbidity and lifetime loss of quality-adjusted life-years. Permanent morbidity leading to a mRS>1 was 4.3 %, 18 %, and 50 % for SM grade 1–2, SM grade 3, and SM grade 4 AVM, respectively. Treatment-related mortality was 0 %. A total of 48 % of cases underwent pre-operative embolization. After performing an analysis comparing the treatment-associated risk with the natural risk of becoming disabled, the authors conclude, and reinforce the evidence also provided by other recent cohort studies [1, 6], that surgery should be considered for patients with SM grades 1–2 (corresponding to Spetzler–Ponce class A)[7] unruptured AVM. As expected, for SM grade 3–4 unruptured AVM the risk of an adverse outcome from surgery was higher. The treatment-related morbidity for this subgroup of cases was similar to the one reported in other previous cohort studies [1, 5]. After performing a QALY analysis and after comparing the treatment morbidity with the

natural history of becoming disabled on the base of the published data, the authors conclude that surgery should not be recommended for patients with an unruptured SM grade 3 or 4 AVM.

There is no doubt that recommending management for patients with unruptured SM grade  $\geq 3$  AVM (Spetzler–Ponce classes B and C) remains a highly nuanced process. This is even more the case for SM grade 3 AVM (Spetzler–Ponce class B). However, when taking into account individual patients, a number of complex factors need to be considered. As previously reported and confirmed by the authors in the present study, despite its high morbidity, microsurgical treatment mortality is likely lower than the long-term mortality if left untreated. In a recent meta-analysis, the annual risk of first AVM hemorrhage has been estimated to be 2.2 % [3], with long-term neurological morbidity and mortality as high as 35 and 29 %, respectively [2]. In a previous study, we found the overall outcome from hemorrhage were a permanent downgrade in function (mR>2) in 69 %, including death in 31 % [1]. This is higher than the higher boundary assumed by Steiger et al. for the purpose of their analysis (15 % risk leading to a mRS>2 and 15 % risk of death after AVM spontaneous hemorrhage). On the other hand, when looking at severe treatment-related morbidity, less than 10 % of cases in the present cohort experienced a major clinical deterioration leading to a permanent mRS>2 and no patient experienced treatment-related mortality. In a published sensitivity analysis of a prospective cohort of 368 unruptured AVM, we found major surgical morbidity (leading to mRS>2) for SM grade 3 AVM to be 4.6 % (95 % CI 1.7–10.6 %) and mortality was less than 1 % [1].

The likely lower mortality rate from surgery for high-grade unruptured AVM may come into play for individual patients, resulting in recommendation for surgery despite the daunting morbidity. That is, sometimes there is a trade of some degree

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of morbidity (e.g., visual field loss) for a greater likelihood of avoiding premature death. We believe that this is especially true, as suggested by the authors, in younger patients.

As late as 1968, Ken Jamieson reported (speaking on a different cerebrovascular subject) that “it is clear that the basilar bifurcation is no place for the faint of heart. Only time and greater experience will indicate whether it is a place for neurosurgeons at all.”[4]. Close to five decades later, a different topic, cerebrovascular neurosurgeons and patients are still faced to the same paradox.

**Conflict of interest** The authors declare that they have no competing interests.

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