Aneurysm surgery with pre-operative 3D planning in a virtual reality environment: Technique and outcome analysis

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Objective:
Aneurysm surgery demands precise spatial understanding of the vascular anatomy and its surroundings. We report on a decade of experience planning clipping procedures pre-operatively in a virtual reality (VR) workstation and present outcomes with respect to mortality, morbidity and aneurysm occlusion rate.

Methods:
Between 2006 and 2015, the clipping of 115 intracranial aneurysms in 105 patients was pre-operatively planned with the Dextroscope, a stereoscopic, patient-specific VR environment. The outcome data for all cases, planned and performed in three institutions, was analyzed based on clinical charts and radiological reports.

Results:
85 incidental, unruptured aneurysms in 77 patients were electively planned and treated surgically. Mortality was 0% and morbidity (modified Rankin score [mRS] >2) was 2.6%. The rate of complete aneurysm obliteration on post-operative imaging was 91.8%. In addition, 30 aneurysms were treated in 28 patients with prior subarachnoid hemorrhage. Mortality in these cases was 3.6%, morbidity (mRS>2) 7.1% and the rate of complete aneurysm clipping was 90%.

Conclusion:
Meticulous 3-dimensional surgical planning in a VR environment enhances the surgeon's spatial understanding of the individual vascular anatomy and allows clip preselection and positioning as well as anticipation of potential difficulties and complications. Virtual reality planning was associated, in this multi-institutional series, with excellent clinical outcomes while maintaining rates of complete aneurysm closure equivalent to benchmark cohorts.
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