ACCURAY

CASE STUDY

# LEFT PARIETAL LOBE ARTERIOVENOUS MALFORMATION (SM GRADE II)


**San Bortolo Hospital CyberKnife® Team:**

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|---|---|
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| CyberKnife Center: | San Bortolo Hospital<br>Vicenza, Italy |


ACCURAY CyberKnife

# LEFT PARIETAL LOBE ARTERIOVENOUS MALFORMATION (SM GRADE II)

## DEMOGRAPHICS

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|---|---|
| **Sex:** | Male |
| **Age:** | 68 Years |
| **Histology:** | Parietal Lobe AVM |

## CLINICAL HISTORY

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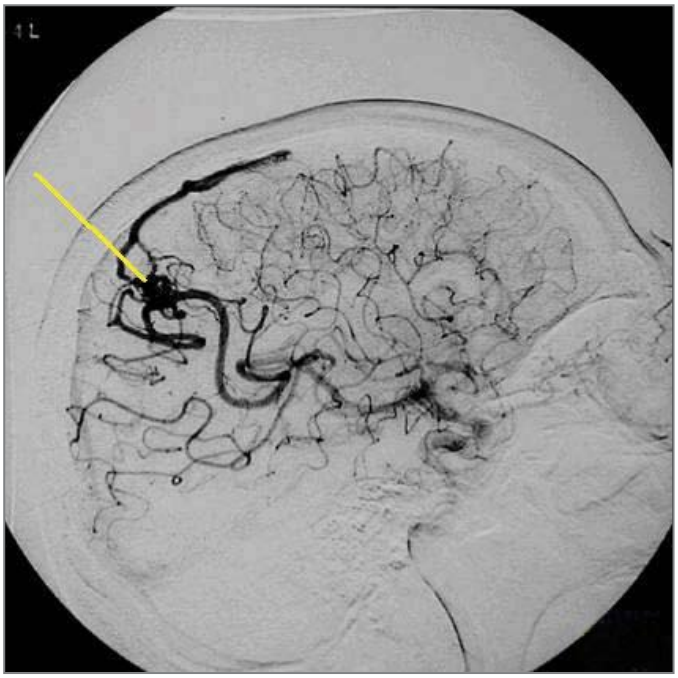
| **Referred by:** | Neurosurgeon |
| **Previous Treatment:** | None |

### Case History

This 68-year-old male presented following a single epileptic episode and was otherwise asymptomatic. An 0.7 $cm^3$ arteriovenous malformation (AVM), Spetzler and Martin grade II, of the left parietal lobe was diagnosed.

### CyberKnife® Treatment Rationale

Treatment of intracranial AVMs was one of the original radiosurgical applications, and radiosurgery has proven an effective modality in this field. Patients are usually referred for radiosurgery in asymptomatic cases, or because of unsuitability for, or refusal of, conventional surgery. In some cases embolization will be attempted prior to radiosurgery (see clinical decision matrix). In the present case, the patient refused conventional surgery and was referred by the neurosurgeon for radiosurgery with the CyberKnife® System.



*Pre-treatment lateral 2D angiography. The nidus is visible (indicated), and its arterial supply (middle cerebral artery) is enlarged.*

*Pre-treatment AP radiograph showing the lesion in the skull.*

**TREATMENT DETAILS**

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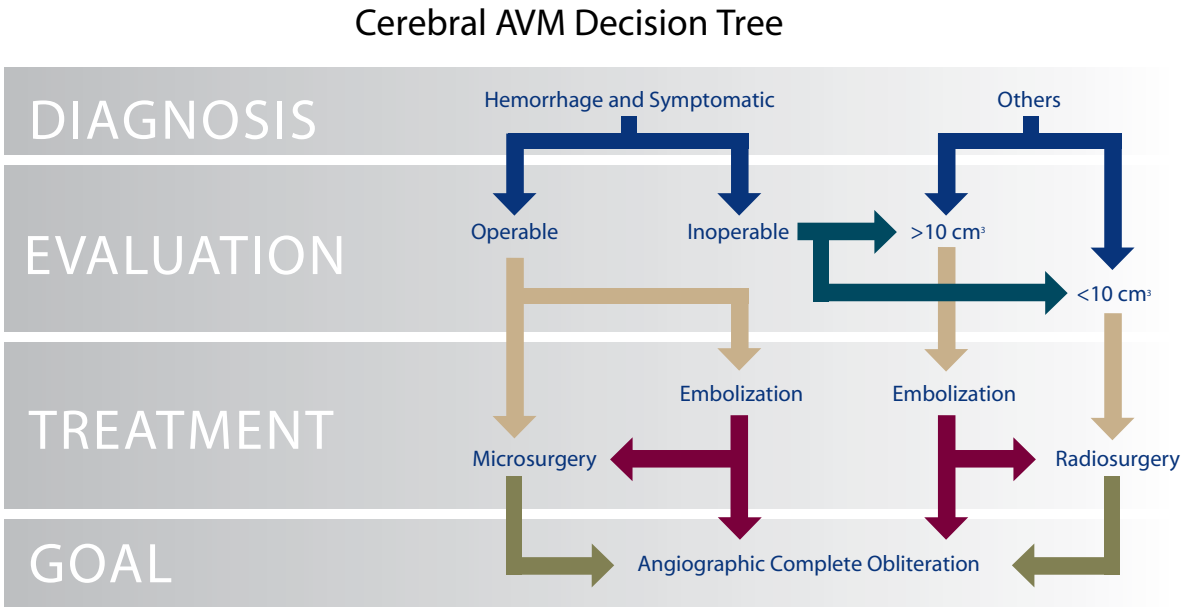
|---|---|---|---|
| **Tumor Volume:** | 0.7 cc | **Fractions / Treatment Time:** | 1 / 50 min |
| **Imaging Technique(s):** | CT, 3DRA | **Path Template:** | 3 path 800 mm |
| **Rx Dose & Isodose:** | 18.9 Gy to 70% | **Tracking Method:** | 6D Skull Tracking |
| **Target Coverage:** | 85% | **Collimator(s):** | 5 mm |
| **Number of Beams:** | 96 | | |

**Treatment Planning Process**

Pre-treatment imaging included 3D Rotational Angiography (3DRA) and CT scans[1,2]. These image-sets were registered using a normalized mutual information algorithm, and the target volume defined using the 3DRA images. For treatment the patient was positioned supine and fitted with a thermoplastic head mask. The treatment plan was generated using a forward planned single isocenter technique and used 96 beams. A dose of 18.9 Gy was prescribed to the 70% isodose and delivered in a single fraction.

**Treatment Delivery**

The patient was treated using the CyberKnife® System with 6D skull tracking. With this tracking method X-ray images of the skull are acquired between treatment beams and compared with digitally reconstructed radiographs (DRRs). The offset of the current skull position from the reference position is calculated, and the robot position adjusted to compensate. This process is performed automatically, and continues throughout treatment. The treatment lasted about 50 minutes including set-up, and was performed as an outpatient procedure.



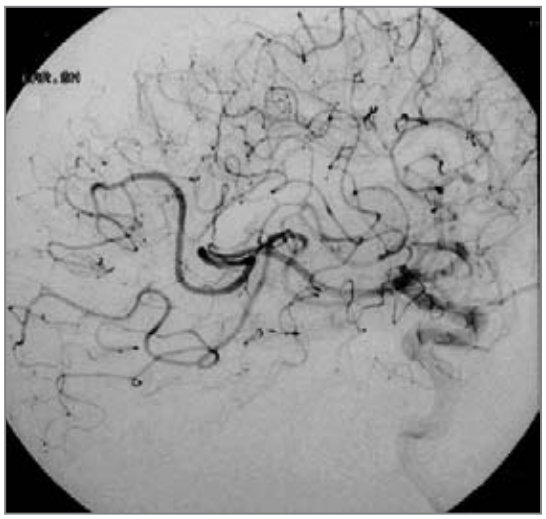

*The clinical decision matrix used in San Bortolo Hospital for treatment of cerebral AVMs. All radiosurgery is performed using the CyberKnife System.*

### Outcome and Follow-Up

Follow-up MR angiography was performed at 6, 12, and 18 months post-treatment, and 2D angiography at 19 months. The 2D angiography shows that the AVM is completely obliterated. The middle cerebral artery remains dilated but this is not considered clinically relevant, and normal arterial function has been preserved. There were no treatment complications.

### Conclusion and CyberKnife® Advantages

3DRA images have been used to accurately define a small intracranial AVM. The CyberKnife® System delivered a painless, complication-free treatment which has resulted in complete AVM obliteration at 19 months post-treatment.



*Lateral 2D angiography at 19 months post-treatment – showing complete nidus obliteration and arterial preservation.*

*AP 2D angiography at 19 months post-treatment.*

## CYBERKNIFE AT SAN BORTOLO HOSPITAL

The CyberKnife System was installed in January 2003, being the first in Europe. By March 2007 it had been used to treat nearly 1200 patients. Radiosurgery for AVMs has been performed in this center since 1984 using a conventional linear accelerator technique with a rigid head-frame[4]. Since 2003 these treatments have been transferred to the CyberKnife System. By March 2007 almost 220 intracranial and spinal AVMs have been treated using the CyberKnife System. Professor Colombo and his team have been pioneers in linac-based radiosurgery systems for over 20 years. Their CyberKnife patient population is approximately 76% intracranial and 24% extracranial.

**References**

1. Stancanello J, Cavedon C, Francescon P, Cerveri P, Ferrigno G, Colombo F, Perini S: Development and validation of a CT-3D rotational angiography registration method for AVM radiosurgery. Medical Physics 31(6):1363-1371, Jun 2004.
2. Colombo F, Cavedon C, Francescon P, Casentini L, Fornezza U, Castellan L, Causin F, Perini S: Three-dimensional angiography for radiosurgical treatment planning for arteriovenous malformations. J Neurosurg 98(3):536-543, Mar 2003.
3. Colombo F, Benedetti A, Pozza F, Zanardo A, Avanzo RC, Chierego G, Marchetti C: Stereotactic radiosurgery utilizing a linear accelerator. Appl Neurophysiol 48(1-6):133-145, 1985.
4. Colombo F, Benedetti A, Pozza F, Marchetti C, Chierego G: Linear accelerator radiosurgery of cerebral arteriovenous malformations. Neurosurgery 24(6):833-840, Jun 1989.

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