Clinics in Surgery

Case Report
Published: 08 Oct, 2021

Rapid Ventricular Pacing in the Semi-Sitting Position for Non-Elective Aneurysm Surgery

Josefin Grabert[1], Markus Velten[1], Lars Eichhorn[1], Mark Coburn[1], Alexis Hadjiathanasiou[2], Patrick Schuss[2], Hartmut Vatter[2] and Erdem Güresir[2]*

[1]*Department of Anesthesiology and Intensive Care Medicine, University Hospital Bonn, Germany*

[2]*Department of Neurosurgery, University Hospital Bonn, Germany*

Abstract

Rapid Ventricular Pacing (RVP) has been described for flow reduction in elective surgery of unruptured intracranial aneurysms. Our patient had a ruptured anterior inferior cerebellar artery aneurysm unfavorable for endovascular treatment. Surgical approach necessitated the semi-sitting position and RVP due to complicated proximal control. Transesophageal echocardiography during anesthesia induction revealed an atrial septal defect. Intraoperative RVP achieved effective hypotension and facilitated successful aneurysm occlusion. Though extensive cardiac workup was not possible in this non-elective surgery, no arrhythmias or complications (i.e., paradoxical air embolism) occurred.

This case demonstrates a safe and effective execution of RVP in the semi-sitting position for surgical clip reconstruction surgery of a ruptured intracranial aneurysm in a patient exhibiting an atrial septal defect.

Keywords: Subarachnoid hemorrhage; Intracranial aneurysm; Rapid ventricular pacing; Clipping; Vascular disorders

OPEN ACCESS

Correspondence:
Josefin Grabert, Department of Anesthesiology and Intensive Care Medicine, University Hospital Bonn, Venusberg-Campus 1, 53127 Bonn, Germany,
E-mail: josefin.grabert@ukbonn.de

Received Date: *20 Sep 2021*
Accepted Date: *05 Oct 2021*
Published Date: *08 Oct 2021*

Citation:
Grabert J, Velten M, Eichhorn L, Coburn M, Hadjiathanasiou A, Schuss P, et al. Rapid Ventricular Pacing in the Semi-Sitting Position for Non-Elective Aneurysm Surgery. Clin Surg. 2021; 6: 3328.

Introduction

The treatment of cerebral aneurysms has evolved over the last decades, however, primary clip reconstruction surgery remains a standard therapy in particular for the treatment of large or giant ruptured and Unruptured Intracranial Aneurysms (UIAs) [1,2]. Surgical treatment is challenging and peri-procedural morbidity and mortality increases with size and complexity (calcification, incorporated vessels, and large neck) [3-5]. Various techniques including temporary clipping, suction induced decompression, hypothermia, and adenosine-induced flow arrest have been described to decompress the aneurysm sack, thereby supporting aneurysm preparation and safe clip positioning [6-8].

Recently, three case reports, a small case series and one prospective study reported Rapid Ventricular Pacing (RVP) as a safe method for flow reduction during elective surgical treatment of unruptured cerebral aneurysms mainly located in the anterior circulation [9-13]. Clip reconstruction for posterior circulation aneurysms is demanding and depending on aneurysm complexity the semi-sitting position offers improved access, gravitational drainage of venous blood, and Cerebrospinal Fluid (CSF) [14]. However, RVP for aneurysm surgery in the semi-sitting position has not been reported, yet.

Approval of the Ethics Committee at the University Hospital Bonn, Germany (Chairperson: Prof. K Racké) was obtained.

Case Presentation

A 64-year-old male patient was transferred to our institution from a secondary hospital where he was administered due to left sided facial paresis accompanied by neck pain and headache the day before admission. An initial Computed Tomography (CT) scan revealed subarachnoid hemorrhage graded Fisher 3°. Upon admission to our emergency department, the patient was conscious, reported moderate headache and lacked any neurological deficit (Hunt & Hess II).

A Digital Subtraction Angiography (DSA) revealed an occluded left Vertebral Artery (VA) with retrograde filling from the contralateral side, and a partially thrombosed left sided distal Anterior Inferior Cerebellar Artery (AICA) aneurysm (6 mm) lateral to the brainstem as the bleeding source

Figure 1: A: Three-dimensional Digital Subtraction Angiography (DSA) showing the aneurysm of the left AICA in the anterior-posterior projection (marked by red circle). B: Projection of the aneurysm of the left AICA with a view angle as seen during the operation (marked by red circle).

(Figure 1). Endovascular treatment was assessed not possible due to the small size of the parent artery and the distal localization of the aneurysm. After interdisciplinary consensus, microsurgical clipping was considered as primary treatment option. Regarding the occluded left VA, proximal control (right VA) for microsurgical treatment was deemed difficult using a far lateral approach [15]. Therefore, the patient was prepared for RVP for flow reduction in the semi-sitting position.

Standard monitoring included electrocardiogram, pulse oximetry, non-invasive blood pressure, and BIS monitoring (Version XP, BIS version 4.0, Medtronic Inc., Dublin, Ireland). Remifentanil and Propofol for anesthesia induction were administered by target controlled infusion (TCI; Alaris TM PK, BD, Heidelberg, Germany) based on the Schnider model [16,17]. Oral intubation under full muscle relaxation, ventilation and invasive blood pressure monitoring were established. A central venous catheter in addition to a vascular introducer sheath (Arrow, 6 Fr. × 10 cm) was inserted through the right internal jugular vein under ultrasound visualization and external defibrillation pads were placed on the chest wall. As routinely performed for semi-sitting procedures, a Transesophageal Echocardiography (TEE) probe (X7-2t, Affiniti 50, Philips Healthcare, Hamburg, Germany) was positioned in the mid esophageal view according to Shanewise et al., focusing the atrial septum [18]. A subsequently executed Valsalva maneuver detected a small atrial septal defect. After discussion of this novel finding the team decided to proceed with the planned procedure and a 5 Fr. bipolar pacing catheter (Edwards Life sciences Services GmbH, Untereschbach, Germany) was advanced through the venous sheath into the right ventricular apex. Correct probe positioning was confirmed by TEE using the four-chamber view and ventricular pacing threshold was identified with a cardiac stimulator, verified by a change in the QRS complex at a frequency of 140 bpm (Pace 203 H, OSYPKA AG, Rheinfelden, Germany). High output pacing (5 mA at 10 msec pulse width) was used to ensure ventricular capture at very rapid rates.

The patient was placed in a semi-sitting position with the head in a Mayfield skull clamp for safe trepanation and preparation. During preparation of the aneurysm neck, the aneurysm ruptured prematurely. RVP was initiated at a rate of 150 bpm and gradually increased to approximately 180 bpm until a Median Arterial blood Pressure (MAP) decrease below 50 mmHg was registered and intra-aneurysmal pressure reduction became evident. After reconstruction of the AICA and placement of the clip, RVP was terminated and sinus rhythm and MAP returned to baseline spontaneously. An intraoperative ICG-angiography verified aneurysm occlusion as well as persistent vessel perfusion. Postoperatively, the patient was transferred to the neuro ICU and presented no deficits after the procedure.

Discussion

To our knowledge, this is the first published case report of a ruptured intracranial aneurysm, treated surgically with the assistance of RVP in the semi-sitting position. Our patient was diagnosed with a ruptured and partially thrombosed AICA aneurysm measuring 6 mm × 3 mm. Clip reconstruction surgery of AICA aneurysms is particularly demanding, given the proximity to the brainstem and cranial nerves as well as narrow surgical accessibility. Considering also the occluded ipsilateral VA, impeding proximal flow control, RVP was accounted to ensure proximal flow control and improve patient safety. With the aid of RVP, deflation of the aneurysm was induced and aneurysmal bleeding was reduced, sparing manipulation of the surrounding structures, such as the facial nerve and brainstem. Furthermore, semi-sitting positioning improved gravitational drainage of venous blood and CSF, minimizing the necessity of brain retraction and improved exposure of the aneurysm.

Although offering various surgical advantages [19], there are still concerns regarding the use of the semi-sitting position during neurosurgical procedures, mainly fear of hemodynamic instability and air embolism [20]. Recently, Guenther and colleagues reported the semi-sitting position to be safe in an experienced team of surgeons and anesthesiologists [21]. The semi-sitting position is an accustomed procedure that is frequently performed at our institution with a standard operating procedure established. This includes preoperative TEE assessment of the atrial septum as well as constant intraoperative TEE to detect and aspirate air *via* a right atrial venous catheter. In the present case, a small atrial septal defect was identified, bearing the risk of a paradoxical air embolism to the heart or brain. Though this is a relative contraindication, balancing risks and benefits of the semi-sitting position in this particular case and considering our experience we accepted the potential risk. Throughout the entire procedure under continuous TEE monitoring, neither cardiovascular instabilities, nor air embolism occurred.

Various supplementary techniques to facilitate neurosurgical clip reconstruction including induced hypotension, suction decompression, temporary clipping, transient cardiac standstill, or

bypass surgery have already been established. Recently, two small series and 3 case reports described the successful use of RVP during aneurysm surgery [9-13]. Depending on the patient's risk factors and aneurysm characteristics, treatment is performed individually.

Given the localization of the aneurysm, with challenging access and crucial tissue surrounding, safe dissection of the aneurysm was imperative. To facilitate such dissection, we used RVP. While RVP is an established concept in neurosurgery, this is the first report using RVP for surgery of an AICA aneurysm with the patient being positioned in the semi-sitting position. Since the introduction of RVP in 1966 it fell out of fashion for years, replaced by hypothermic arrest and adenosine-induced hypotension subsequently. There are serious RVP associated risks, most importantly arrhythmias including ventricular tachycardia and ventricular fibrillation. In a prospective study, including 20 patients who underwent RVP for UIA surgery, Konczalla and colleagues reported a supraventricular tachycardia in one patient that was terminated by electrical cardioversion and ventricular fibrillation due to extensive stimulation in one other patient, requiring 50s of chest compressions before spontaneous recovery [13]. However, no arrhythmias or signs of Myocardial Injury after Non-Cardiac Surgery (MINS) were detected within 24 h after the procedure. The authors speculate that volume loading may prevent cardiac arrhythmias and 10s of RVP may be safe. The study population included in this study received extensive cardiac evaluation including ECG, treadmill ECG, and TTE evaluation prior to RVP and patients with structural heart disease or conductance abnormalities were excluded for the study.

We used RVP for the treatment of a ruptured aneurysm in a patient American Society of Anesthesia classification III with pre-existing conditions including hypertension, paroxysmal atrial fibrillation, obesity, and cerebral residues from a stroke in 2011. Given the urgency in this case, extensive cardiac evaluation is not feasible, and only the perioperative TEE revealed a small atrial septal defect. Although exhibiting a cardiac risk profile including pre-existing arrhythmias, the patient converted to sinus rhythm after RVP was terminated. Venous catheter associated risks such as venous dissection, pneumothorax or cardiac perforation resulting in cardiac tamponade did not occur. More frequently, RVP is used during Transcatheter Aortic Valve Implantation (TAVI) in patients with Low-Flow, Low-Gradient (LFLG) Aortic Stenosis (AS) and therefore a higher periprocedural risk than our patient. Recently, Fischer-Rasokat and colleagues reported that one-year mortality is not influenced by RVP in LFLG patients for TAVI implantation, concluding that RVP during implantation of self-expandable TAVI prostheses should not be withheld in an attempt to achieve optimal conditions, even in high risk LFLG-AS patients [22].

Conclusion

Here we demonstrate a case where RVP was used safely and effectively for microsurgical treatment of an aneurysm in the posterior fossa - i.e., a ruptured AICA aneurysm - in the semi-sitting position. Continuous TEE monitoring showed no sign of air embolism, despite a previously unknown atrial septal defect. Also, no arrhythmias or cardiovascular side effects from RVP were detected. This procedure might be considered by an experienced neuro-anesthesiological and neurosurgical team as a new tool for complex neurovascular procedures.

References

1. Abecassis IJ, Zeeshan Q, Ghodke BV, Levitt MR, Ellenbogen RG, Sekhar LN. Surgical versus endovascular management of ruptured and unruptured intracranial aneurysms: Emergent issues and future directions. World Neurosurg. 2020;136:17-27.
2. Lindgren A, Vergouwen MD, van der Schaaf I, Algra A, Wermer M, Clarke MJ, et al. Endovascular coiling versus neurosurgical clipping for people with aneurysmal subarachnoid haemorrhage. Cochrane Database Syst Rev. 2018;8:CD003085.
3. Daou B, Chalouhi N, Starke RM, Barros G, Ya'qoub L, Do J, et al. Clipping of previously coiled cerebral aneurysms: efficacy, safety, and predictors in a cohort of 111 patients. J Neurosurg. 2016;125(6):1337-43.
4. Darsaut TE, Darsaut NM, Chang SD, Silverberg GD, Shuer LM, Tian L, et al. Predictors of clinical and angiographic outcome after surgical or endovascular therapy of very large and giant intracranial aneurysms. Neurosurgery. 2011;68(4):903-15;discussion 915.
5. Platz J, Wagner M, Güresir E, You S-J, Konczalla J, de Rochemont R du M, et al. Early diffusion-weighted MRI lesions after treatment of unruptured intracranial aneurysms: A prospective study. J Neurosurg. 2017;126(4):1070-8.
6. Bendok BR, Gupta DK, Rahme RJ, Eddleman CS, Adel JG, Sherma AK, et al. Adenosine for temporary flow arrest during intracranial aneurysm surgery: A single-center retrospective review. Neurosurgery. 2011;69(4):815-20; discussion 820-821.
7. Eliava SS, Filatov YM, Yakovlev SB, Shekhtman OD, Kheireddin AS, Sazonov IA, et al. Results of microsurgical treatment of large and giant ICA aneurysms using the Retrograde Suction Decompression (RSD) technique: Series of 92 patients. World Neurosurg. 2010;73(6):683-7.
8. Fulkerson DH, Horner TG, Payner TD, Leipzig TJ, Scott JA, Denardo AJ, et al. Endovascular retrograde suction decompression as an adjunct to surgical treatment of ophthalmic aneurysms: Analysis of risks and clinical outcomes. Neurosurgery. 2009;64(3):ons107-111; discussion ons111-112.
9. Khan SA, Berger M, Agrawal A, Huang M, Karikari I, Nimjee SM, et al. Rapid ventricular pacing assisted hypotension in the management of sudden intraoperative hemorrhage during cerebral aneurysm clipping. Asian J Neurosurg. 2014;9(1):33-5.
10. Nimjee SM, Smith TP, Kanter RJ, Ames W, Machovec KA, Grant GA, et al. Rapid ventricular pacing for a basilar artery pseudoaneurysm in a pediatric patient: Case report. J Neurosurg Pediatr. 2015;15(6):625-9.
11. Saldien V, Menovsky T, Rommens M, Van der Steen G, Van Loock K, Vermeersch G, et al. Rapid ventricular pacing for flow arrest during cerebrovascular surgery: revival of an old concept. Neurosurgery. 2012;70(2):270-5.
12. Whiteley JR, Payne R, Rodriguez-Diaz C, Ellegala DB, Reeves ST. Rapid ventricular pacing: A novel technique to decrease cardiac output for giant basilar aneurysm surgery. J Clin Anesth. 2012;24(8):656-8.
13. Konczalla J, Platz J, Fichtlscherer S, Mutlak H, Strouhal U, Seifert V. Rapid ventricular pacing for clip reconstruction of complex unruptured intracranial aneurysms: Results of an interdisciplinary prospective trial. J Neurosurg. 2018;128(6):1741-52.
14. Yonekawa Y. [(12) Revascularisation and aneurysms of the posterior circulation]. No Shinkei Geka. 2014;42(4):375-96.
15. Heros RC, Ojemann RG, Crowell RM. Superior temporal gyrus approach to middle cerebral artery aneurysms: Technique and results. Neurosurgery. 1982;10(3):308-13.
16. Schnider TW, Minto CF, Gambus PL, Andresen C, Goodale DB, Shafer SL, et al. The influence of method of administration and covariates on the pharmacokinetics of propofol in adult volunteers. Anesthesiology. 1998;88(5):1170-82.

17. Soehle M, Wolf CF, Priston MJ, Neuloh G, Bien CG, Hoeft A, et al. Comparison of propofol pharmacokinetic and pharmacodynamic models for awake craniotomy: A prospective observational study. Eur J Anaesthesiol. 2015;32(8):527-34.

18. Shanewise JS, Cheung AT, Aronson S, Stewart WJ, Weiss RL, Mark JB, et al. ASE/SCA guidelines for performing a comprehensive intraoperative multiplane transesophageal echocardiography examination: Recommendations of the American Society of Echocardiography Council for Intraoperative Echocardiography and the Society of Cardiovascular Anesthesiologists Task Force for Certification in Perioperative Transesophageal Echocardiography. J Am Soc Echocardiogr. 1999;12(10):884-900.

19. Fathi A-R, Eshtehardi P, Meier B. Patent foramen ovale and neurosurgery in sitting position: A systematic review. Br J Anaesth. 2009;102(5):588-96.

20. Kaye AH, Leslie K. The sitting position for neurosurgery: Yet another case series confirming safety. World Neurosurg. 2012;77(1):42-3.

21. Günther F, Frank P, Nakamura M, Hermann EJ, Palmaers T. Venous air embolism in the sitting position in cranial neurosurgery: Incidence and severity according to the used monitoring. Acta Neurochir. 2017;59:339-46.

22. Fischer-Rasokat U, Renker M, Liebetrau C, Möllmann H, Hamm CW, Kim W-K. Impact of rapid ventricular pacing during transcatheter implantation of self-expanding aortic valve prostheses in patients at highest risk. J Invasive Cardiol. 2020;32(12):E355-61.