Maxillofacial and brain surgeries and stress response

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ABSTRACT

Despite significant improvement in diagnostic and therapeutic technology over the past decades, mortality rates after cancer surgery (including brain tumor resection) remains high. Perioperative stress on the nervous system and the resultant central nervous system (CNS) changes are likely to be causative for altered behaviors that are seen postoperatively, including chronic pain, posttraumatic stress disorder, and learning difficulties. Improving the ability of the anesthesiologist to control all four components of acute perioperative stress could potentially reduce the negative impact of surgery on the brain.

Keywords: anesthesia, neurosurgery, spine, stress, drugs.

TEXT

Anesthetics may influence cancer recurrence and metastasis following surgery by modulating the neuroendocrine stress response or by directly affecting cancer cell biology.[1-8] Saito et al.[1] summarized the current evidence on whether commonly used anesthetics potentially affect postoperative outcomes following solid organ cancer surgery with particular focus on neurological malignancies. Postoperative delirium (POD) is a common complication following surgery and anesthesia.[2] Mitochondrial dysfunction, which is demonstrated by energy deficits and excessively activated oxidative stress, has been reported to contribute to POD.[2,9-15] The dynamic balance between mitochondrial fusion and fission processes is critical in regulating mitochondrial function. However, the impact of Surgery/Anesthesia on mitochondrial fusion/fission dynamics remains unclear.[2,16-21] The anesthesia/surgery induced greater postoperative delirium-like behavior, increased brain IL-6 levels, decreased PSD-95 and synaptophysin levels, and mitochondrial dysfunction in 18 than 9 months old mice.[22] Treatments with Lactobacillus and probiotic mitigated the anesthesia/surgery-induced changes. These data suggest that microbiota dysbiosis may contribute to neuropathogenesis of postoperative delirium and treatment with Lactobacillus or a probiotic could mitigate postoperative delirium.[3,5,19,22] Despite significant improvement in diagnostic and therapeutic technology over the past decades, mortality rates after cancer surgery (including brain tumor resection) remains high.[1] With regards to brain tumors, interaction between microglia/macrophages and tumor cells by multiple biological factors play an important role in tumor progression and metastasis.[1,4,22-30] Preclinical studies have demonstrated an association between anesthetics and brain tumor cell biology, and a potential effect on tumor progression and metastasis has been

revealed.[1,31-35] However, in the clinical setting, the current evidence is inadequate to draw firm conclusions on the optimal anesthetic technique for brain tumor surgery.[1,36-38] The anesthesia/surgery increased brain IL-6 levels in aged mice. These findings are consistent with the clinical observation that the elevation of plasma IL-6 level is associated with postoperative delirium in patients.[39-45] However, the results from the current studies and our previous studies also showed that the increases in mouse brain and plasma levels of IL-6 were age-dependent.[45,46-50] These findings would lead to future mechanistic investigation in animals to illustrate the underlying mechanism and clinical studies in patients to reveal the clinical relevance of the age-dependent changes in IL-6 levels.[45] Given the findings that the anesthesia/surgery was able to increase BBB permeability to small, but not big, molecules, next, we compared the effects of the anesthesia/surgery on the levels of β-catenin, tight junction proteins claudin, occludin, and ZO-1, and adherent junction proteins VE-cadherin, E-cadherin, and p120-catenin in cortex and hippocampus of 18-month-old mice.[51] Anesthesia is a state of drug-induced unconsciousness with suppression of sensory perception, and consists of both hypnotic and analgesic components.[52-60] The anesthesiologist monitors the clinical response to noxious stimuli and adjusts drug dosage to achieve an adequate depth of anesthesia, with the aim of reducing operative stress. Acute stress in the perioperative period has four major contributors: anxiety, pain, the surgical stress response, and the potential neurotoxicity of anesthetic agents. Any or all of these may act deleteriously on multiple systems in the brain and have known significant effects on brain regions such as the hippocampus and the hypothalamic-pituitary-adrenal axis.[52,61,62] Perioperative stress on the nervous system and the resultant central nervous system (CNS) changes are likely to be causative for altered behaviors that are seen postoperatively, including chronic pain, posttraumatic stress disorder, and learning difficulties. Improving the ability of the anesthesiologist to control all four components of acute perioperative stress could potentially reduce the negative impact of surgery on the brain. Currently, there is no objective measurement for any of these stressors.[52,63,64] In conclusion, surgery/anesthesia disturbed mitochondrial fission/fusion dynamics and then impaired mitochondrial function in the brain of aged mice; these effects may be involved in the underlying mechanism of POD. Further studies are needed.

REFERENCES

[1] Saito J, Masters J, Hirota K, Ma D. Anesthesia and brain tumor surgery: technical considerations based on current research evidence. Curr Opin Anaesthesiol. 2019;32(5):553-562.

[2] Lu Y, Chen L, Ye J, Chen C, Zhou Y, Li K, Zhang Z, Peng M. Surgery/Anesthesia disturbs mitochondrial fission/fusion dynamics in the brain of aged mice with postoperative delirium. Aging (Albany NY). 2020;12(1):844-865.

[3] Rapone B, Ferrara E, Qorri E, et al. The Impact of Periodontal Inflammation on Endothelial Function Assessed by Circulating Levels of Asymmetric Dimethylarginine: A Single-Blinded Randomized Clinical Trial. Journal of Clinical Medicine. 2022;11(14):4173.

[4] Rapone B, Pedone S, Carnevale A, et al. Profilometer Comparison of the Surface Roughness of Four Denture Base Resins: An In Vitro Study. Applied Sciences. 2022;12(4):1837.

[5] Corsalini M, Di Venere D, Carossa M, et al. Comparative clinical study between zirconium-ceramic and metal-ceramic fixed rehabilitations. Oral Implantology 2018;11(3):150–160.

[6] Das S, et al. Resolution of Papilledema Following Ventriculoperitoneal Shunt or Endoscopic Third Ventriculostomy for Obstructive Hydrocephalus: A Pilot Study. Medicina (Kaunas). 2022;58(2):281.

[7] Pasqualetti F, Montemurro N, Desideri I, et al. Impact of recurrence pattern in patients undergoing a second surgery for recurrent glioblastoma. Acta Neurol Belg. 2022;122(2):441-446.

[8] Di Naro E, Loverro M, Converti I, et al. The Effect of Menopause Hypoestrogenism on Osteogenic Differentiation of Periodontal Ligament Cells (PDLC) and Stem Cells (PDLCs): A Systematic Review. Healthcare (Basel) 2021;9(5):572.

[9] Rapone B, Converti I, Santacroce L, et al. Impact of Periodontal Inflammation on Nutrition and Inflammation Markers in Hemodialysis Patients. Antibiotics 2019;8(4):209.

[10] Corsalini M, Rapone B, Cagnetta G, et al. Orofacial functions and chewing effiency in elderly patients with Parkinsons's disease rehabilitated with removable prostheses. The Open Dentistry 2020;14:13-18.

[11] Montemurro N, Aliaga N, Graff P, Escribano A, Lizana J. New Targets and New Technologies in the Treatment of Parkinson's Disease: A Narrative Review. Int J Environ Res Public Health. 2022;19(14):8799.

[12] De Luca P, Camaioni A, Marra P, et al. Effect of Ultra-Micronized Palmitoylethanolamide and Luteolin on Olfaction and Memory in Patients with Long COVID: Results of a Longitudinal Study. Cells. 2022;11(16):2552.

[13] Montemurro N, Murrone D, Romanelli B, Ierardi A. Postoperative Textiloma Mimicking Intracranial Rebleeding in a Patient with Spontaneous Hemorrhage: Case Report and Review of the Literature. Case Rep Neurol. 2020;12(1):7-12.

[14] Rapone B, Ferrara E, Montemurro N, et al. Oral microbiome and preterm birth: correlation or coincidence? A narrative review. Open Access Macedonian Journal of Medical Sciences 2020;8(F):123-132.

[15] Pasqualetti F, Gabelloni M, Gonnelli A, et al. Impact of temporalis muscle thickness in elderly patients with newly diagnosed glioblastoma treated with radio or radio-chemotherapy. Radiol Med. 2022;127(8):919-924.

[16] Rapone B, Ferrara E, Santacroce L, et al. Gingival crevicular blood as a potential screening tool: a cross sectional comparative study. Int. J. Environ. Res. Public Health 2020;17(20):7356.

[17] Corsalini M, Di Venere D, Sportelli P, et al. Evaluation of prosthetic quality and masticatory efficiency in patients with total removable prosthesis: study of 12 cases. Oral Implantology 2018;11(4):230–240.

[18] Lizana J, Reinoso CMD, Aliaga N, et al. Bilateral central retinal artery occlusion: An exceptional complication after frontal parasagittal meningioma resection. Surg Neurol Int. 2021;12:397.

[19] Montemurro N, Perrini P, Marani W, et al. Multiple Brain Abscesses of Odontogenic Origin. May Oral Microbiota Affect Their Development? A Review of the Current Literature. Appl. Sci. 2021;11:3316.

[20] Di Venere D, Rapone B, Corsalini M. Dental trauma in the anterior sector: an analysis of the predisposing factors in a group of orthodontic patients. Clinica Terapeutica 2020;171(6):e481-485.

[21] Rapone B., Palmisano C., Ferrara E., Di Venere D., Albanese G., Corsalini M. The Accuracy of Three Intraoral Scanners in the Oral Environment with and without Saliva: A Comparative Study. Appl. Sci. 2020;10(21):7762.

[22] Liufu N, Liu L, Shen S, Jiang Z, Dong Y, Wang Y, Culley D, Crosby G, Cao M, Shen Y, Marcantonio E, Xie Z, Zhang Y. Anesthesia and surgery induce age-dependent changes in behaviors and microbiota. Aging (Albany NY). 2020;12(2):1965-1986.

[23] Montemurro N. Telemedicine: Could it represent a new problem for spine surgeons to solve? Global Spine J. 2022;12(6):1306-1307.

[24] Montemurro N, Santoro G, Marani W, Petrella G. Posttraumatic synchronous dou-

ble acute epidural hematomas: Two craniotomies, single skin incision. Surg Neurol Int. 2020;11:435.

[25] Ahsan MK, Hossain MR, Khan MSI, et al. Lumbar revision microdiscectomy in patients with recurrent lumbar disc herniation: A single-center prospective series. Surg Neurol Int. 2020;11:404.

[26] Chavda V, Chaurasia B, Fiorindi A, et al. Ischemic Stroke and SARS-CoV-2 Infection: The Bidirectional Pathology and Risk Morbidities. Neurol Int. 2022;14(2):391-405.

[27] Montemurro N, Condino S, Carbone M, et al. Brain Tumor and Augmented Reality: New Technologies for the Future. Int J Environ Res Public Health. 2022;19(10):6347.

[28] Rapone B, Ferrara E, Santacroce L, et al. The Gaseous Ozone Therapy as a Promising Antiseptic Adjuvant of Periodontal Treatment: A Randomized Controlled Clinical Trial. Int J Environ Res Public Health. 2022;19(2):985.

[29] Benet A, et al. Management of a Ruptured Posterior Inferior Cerebellar Artery (PICA) Aneurysm With PICA-PICA In Situ Bypass and Trapping: 3-Dimensional Operative Video. Oper Neurosurg (Hagerstown). 2017;13(3):400.

[30] Owen CM, et al. Blister Aneurysms of the Internal Carotid Artery: Microsurgical Results and Management Strategy. Neurosurgery. 2017;80(2):235-247.

[31] Montemurro N, Scerrati A, Ricciardi L, Trevisi G. The Exoscope in Neurosurgery: An Overview of the Current Literature of Intraoperative Use in Brain and Spine Surgery. J Clin Med. 2021;11(1):223.

[32] Montemurro N, Perrini P, Lawton MT. Unsuccessful bypass and trapping of a giant dolichoectatic thrombotic basilar trunk aneurysm. What went wrong? Br J Neurosurg. 2022;17:1-4.

[33] Montemurro N, Condino S, Cattari N, et al. Augmented Reality-Assisted Craniotomy for Parasagittal and Convexity En Plaque Meningiomas and Custom-Made Cranio-Plasty: A Preliminary Laboratory Report. Int J Environ Res Public Health. 2021;18(19):9955.

[34] Ricciardi L, Pucci R, Piazza A, et al. Role of stem cells-based in facial nerve reanimation: A meta-analysis of histological and neurophysiological outcomes. World J Stem Cells 428-420:(6)14;2022.

[35] Montemurro N, Ortenzi V, Naccarato GA, et al. Angioleiomyoma of the knee: An uncommon cause of leg pain. A systematic review of the literature. Interdiscip Neurosurg. 2020;22:100877.

[36] Marani W, Mannará F, Noda K, et al. Management of an Uncommon Complication: Anterior Choroidal Artery Occlusion by Posterior Clinoid Process Detected Through Intraoperative Monitoring After Clipping of Paraclinoid Aneurysm: 2-Dimensional Operative Video. Oper Neurosurg (Hagerstown). 2021;21(2):E124-E125.

[37] Rapone B, Inchingolo AD, Trasarti S, et al. Long-Term Outcomes of Implants Placed in Maxillary Sinus Floor Augmentation with Porous Fluorohydroxyapatite (Algipore®FRIOS®) in Comparison with Anorganic Bovine Bone (Bio-Oss®) and Platelet Rich Plasma (PRP): A Retrospective Study. J Clin Med. 2022;11(9):2491.

[38] Montemurro N, Benet A, Lawton MT. Clipping of Ruptured Residual Anterior Communicating Artery Aneurysm After Endovascular Coiling: 3-Dimensional Operative Video. Oper Neurosurg (Hagerstown). 2016;12(1):93-94.

[39] Murrone D, Romanelli B, et al. Falcine meningioma in Von Hippel-Lindau disease: An unusual association. Surg Neurol Int. 2018;9:37.

[40] Vaccaro AR, Lambrechts MJ, Karamian BA, et al. Global Validation of the AO Spine Upper Cervical Injury Classification. Spine (Phila Pa 1976). 2022 Jul 25.

[41] Pasqualetti F, Malfatti G, Cantarella M, et al. Role of magnetic resonance imaging

following postoperative radiotherapy in clinical decision-making of patients with high-grade glioma. Radiol Med. 2022;127(7):803-808.

[42] Montemurro N, Cocciaro A, Liberti G, et al. The internal trabecular bone structure of the odontoid process of the axis. A retrospective single-center comparative study in patients following cervical trauma. J Neurol Surg A Cent Eur Neurosurg. 2022 Oct 17.

[43] Owen CM, Montemurro N, Lawton MT. Microsurgical Management of Residual and Recurrent Aneurysms After Coiling and Clipping: An Experience With 97 Patients. Neurosurgery. 2015;62 Suppl 1:92-102.

[44] Lambrechts MJ, Schroeder GD, Karamian BA, et al. Effect of surgical experience and spine subspecialty on the reliability of the AO Spine Upper Cervical Injury Classification System. J Neurosurg Spine. 2022;19:1-11.

[45] Kowalska K, Klimiec E, Weglarczyk K, Pera J, Slowik A, Siedlar M, Dziedzic T. Reduced ex vivo release of pro-inflammatory cytokines and elevated plasma interleukin-6 are inflammatory signatures of post-stroke delirium. J Neuroinflammation. 2018;15(1):111.

[46] Yang S, Gu C, Mandeville ET, Dong Y, Esposito E, Zhang Y, Yang G, Shen Y, Fu X, Lo EH, Xie Z. Anesthesia and Surgery Impair Blood-Brain Barrier and Cognitive Function in Mice. Front Immunol. 2017;8:902.

[47] Montemurro N, Benet A, Lawton MT. Julius Caesar's Epilepsy: Was It Caused by A Brain Arteriovenous Malformation? World Neurosurg. 2015;84(6):1985-1987.

[48] Scarola R, Montemurro N, Ferrara E, Corsalini M, Converti I, Rapone B. Temporomandibular Disorders and Fibromyalgia: A Narrative Review. Open Access Maced J Med Sci 2021;9(F):106-12.

[49] Montemurro N, Perrini P, Vannozzi R. Epidural spinal cord compression in Langerhans cell histiocytosis: a case report. Br J Neurosurg. 2013;27(6):838-839.

[50] Lorusso F, Postiglione F, Delvecchio M, et al. The impact of diabetes on implant oral rehabilitations: a bibliometric study and literature review. Acta Medica Mediterranea 2020;36:3333.

[51] Borsook D, George E, Kussman B, Becerra L. Anesthesia and perioperative stress: consequences on neural networks and postoperative behaviors. Prog Neurobiol. 2010;92(4):601-612.

[52] Borsook D, George E, Kussman B, Becerra L. Anesthesia and perioperative stress: consequences on neural networks and postoperative behaviors. Prog Neurobiol. 2010;92(4):601-612.

[53] Montemurro N, Indaimo A, Di Carlo DT, et al. Surgical Treatment of Long-Standing Overt Ventriculomegaly in Adults (LOVA): A Comparative Case Series between Ventriculoperitoneal Shunt (VPS) and Endoscopic Third Ventriculostomy (ETV). Int J Environ Res Public Health. 2022;19(4):1926.

[54] Mishra R, Narayanan MDK, Umana GE, et al. Virtual Reality in Neurosurgery: Beyond Neurosurgical Planning. Int J Environ Res Public Health. 2022;19(3):1719.

[55] Rapone B, Ferrara E, Santacroce L, et al. Periodontal Microbiological Status Influences the Occurrence of Cyclosporine□A and Tacrolimus□ Induced Gingival Overgrowth. Antibiotics 2019;8(3):124.

[56] Mishra R, Deora H, Florez-Perdomo WA, et al. Clinical and Radiological Characteristics for Recurrence of Chronic Subdural Hematoma: A Systematic Review and Meta-Analysis. Neurol Int. 2022;26;14(3):683-695.

[57] Encarnacion M, Nurmukhametov R, Barrientos RE, et al. Anatomical Variations of the Median Nerve: A Cadaveric Study. Neurol Int. 2022;14(3):664-672.

[58] Lizana J, Montemurro N, Aliaga N, et al. From textbook to patient: a practical guide

to train the end-to-side microvascular anastomosis. Br J Neurosurg. 2021;7:1-5.

[59] Lizana J, Aliaga N, Marani W, et al. Spinal Vascular Shunts: Single-Center Series and Review of the Literature of Their Classification. Neurol Int. 2022;14(3):581-599.

[60] Montemurro N, Lorenzini D, Ortenzi V, Giorgetti J. Stretched intradural extramedullary tanycytic ependymoma of the thoracic spine. 2022;13:426.

[61] Ahsan K, Khan SI, Zaman N, et al. Fusion versus nonfusion treatment for recurrent lumbar disc herniation. J Craniovertebr Junction Spine. 2021;12(1):44-53.

[62] Chaurasia B, Chavda V, Lu B, et al. Cognitive deficits and memory impairments after COVID-19 (Covishield) vaccination. Brain Behav Immun Health. 2022;22:100463.

[63] Senatore V, Cione E, Gnoni A, Genchi G. Retinoylation reactions are inversely related to the cardiolipin level in testes mitochondria from hypothyroid rats. J Bioenerg Biomembr. 2010;42(4):321-8.

[64] Dang QT, Huynh TD, Inchingolo F, et al. Human Chondrocytes from Human Adipose Tissue-Derived Mesenchymal Stem Cells Seeded on a Dermal-Derived Collagen Matrix Sheet: Our Preliminary Results for a Ready to Go Biotechnological Cartilage Graft in Clinical Practice. Stem Cells Int. 2021;2021:6664697.