·诊疗指南·

唤醒状态下切除脑功能区胶质瘤手术技术指南(2018 版)

中国脑胶质瘤协作组，中国医师协会脑胶质瘤专业委员会

【关键词】神经胶质瘤；脑功能区；唤醒麻醉；指南
中图分类号：R730.264，R739.41　　文献标志码：A　　doi：10.11850/j.issn.1009−122X.2018.08.015

【参 考 文 献】

[1] 编写组中国中枢神经系统胶质瘤诊断和治疗指南. 中国中枢神经系统胶质瘤诊断和治疗指南 (2012)[J]. 中华医学杂志,2013,93(31):2418-2449.

[2] TATE M C, HERBET G, MORITZ-GASSER S, et al. Probabilistic map of critical functional regions of the human cerebral cortex: Broca's area revisited [J]. Brain, 2014, 137 (Pt 10): 2773-2782.

[3] CHANG E F, BRESHEARS J D, RAYGOR K P, et al. Stereotactic probability and variability of speech arrest and anomia sites during stimulation mapping of the language dominant hemisphere [J]. J Neurosurg, 2017, 126(1): 114-121.

[4] WU J, LU J, ZHANG H, et al. Probabilistic map of language regions: challenge and implication [J]. Brain, 2015, 138(Pt 3): e337.

[5] WU J, LU J, ZHANG H, et al. Direct evidence from intraoperative electrocortical stimulation indicates shared and distinct speech production center between Chinese and English languages [J]. Hum Brain Mapp, 2015, 36(12): 4972-4985.

[6] TETTAMANTI M, WENIGER D. Broca's area: a supramodal hierarchical processor [J]? Cortex, 2006, 42(4): 491-494.

[7] MAGILL S T, HAN S J, LI J, et al. Resection of primary motor cortex tumors: feasibility and surgical outcomes [J]. J Neurosurg, 2017, 8: 1-12.

[8] LIMA G L O, DEZAMIS E, CORNS R, et al. Surgical resection of incidental diffuse gliomas involving eloquent brain areas. Rationale, functional, epileptological and oncological outcomes [J]. Neurochirurgie, 2017, 63(3): 250-255.

[9] DUFFAU H. Stimulation mapping of white matter tracts to study brain functional connectivity [J]. Nat Rev Neurol, 2015, 11(5): 255-265.

[10] KEMERDERE R, DE CHAMPFLEUR N M, DEVERDUN J, et al. Role of the left frontal aslant tract in stuttering: a brain stimulation and tractographic study [J]. J Neurol, 2016, 263(1): 157-167.

[11] KINOSHITA M, NAKAJIMA R, SHINOHARA H, et al. Chronic spatial working memory deficit associated with the superior longitudinal fasciculus: a study using voxel-based lesion-symptom mapping and intraoperative direct stimulation in right prefrontal glioma surgery [J]. J Neurosurg, 2016, 125(4): 1024-1032.

[12] KINOSHITA M, DE CHAMPFLEUR N M, DEVERDUN J, et al. Role of fronto-striatal tract and frontal aslant tract in movement and speech: an axonal mapping study [J]. Brain Struct Funct, 2015, 220(6): 3399-3412.

[13] FUJII M, MAESAWA S, MOTOMURA K, et al. Intraoperative subcortical mapping of a language-associated deep frontal tract connecting the superior frontal gyrus to Broca's area in the dominant hemisphere of patients with glioma [J]. J Neurosurg, 2015, 122(6): 1390-1396.

[14] SANAI N, BERGER M S. Intraoperative stimulation techniques for functional pathway preservation and glioma resection [J]. Neurosurg Focus, 2010, 28(2): E1.

[15] DE WITT H P, ROBLES S G, ZWINDERMAN A H, et al. Impact of intraoperative stimulation brain mapping on glioma surgery outcome: a meta-analysis [J]. J Clin Oncol, 2012, 30(20): 2559-2565.

[16] VALLAR G. Neuroanatomy of cognition, neuroanatomy and cognition [J]. Cortex, 2004, 40(1): 223-225.

[17] DUFFAU H, CAPELLE L, SICHEZ N, et al. Intraoperative mapping of the subcortical language pathways using direct stimulations. An anatomo-functional study [J]. Brain, 2002, 125(Pt 1): 199-214.

[18] FABBRO F. The bilingual brain: cerebral representation of languages [J]. Brain Lang, 2001, 79(2): 211-222.

[19] PARADIS M. The neurolinguistics of bilingualism in the next decades [J]. Brain Lang, 2000, 71(1): 178-180.

[20] PARADIS M. Generalizable outcomes of bilingual aphasia esearch [J]. Folia Phoniatr Logop, 2000, 52(1-3): 54-64.

[21] PRICE C J. The anatomy of language: a review of 100 fMRI studies published in 2009 [J]. Ann N Y Acad Sci,2010, 1191: 62-88.

[22] VASSAL F, BOUTET C, LEMAIRE J J, et al. New insights into the functional significance of the frontal aslant tract: an anatomo-functional study using intraoperative electrical stimulations combined with diffusion tensor imaging-

based fiber tracking [J]. Br J Neurosurg, 2014, 28(5): 685-687.

[23] GUILLEVIN R, MENUEL C, DUFFAU H, et al. Proton magnetic resonance spectroscopy predicts proliferative activity in diffuse low-grade gliomas [J]. J Neurooncol, 2008, 87(2): 181-187.

[24] LAW M, YANG S, WANG H, et al. Glioma grading: sensitivity, specificity, and predictive values of perfusion MR imaging and proton MR spectroscopic imaging compared with conventional MR imaging [J]. Am J Neuroradiol, 2003, 24(10): 1989-1998.

[25] XIE J, CHEN X Z, JIANG T, et al. Preoperative blood oxygen level-dependent functional magnetic resonance imaging in patients with gliomas involving the motor cortical areas [J]. Chin Med J (Engl), 2008, 121(7): 631-635.

[26] BELLIVEAU J W, KENNEDY D N JR, MCKINSTRY R C, et al. Functional mapping of the human visual cortex by magnetic resonance imaging [J]. Science, 1991, 254(5032): 716-719.

[27] JACK C R JR, THOMPSON R M, BUTTS R K, et al. Sensory motor cortex: correlation of presurgical mapping with functional MR imaging and invasive cortical mapping [J]. Radiology, 1994, 190(1): 85-92.

[28] FANG S, LIANG J, QIAN T, et al. Anatomic location of tumor predicts the accuracy of motor function localization in diffuse lower-grade gliomas involving the hand knob area [J]. Am J Neuroradiol, 2017, 38(10): 1990-1997.

[29] HERVEY-JUMPER S L, LI J, LAU D, et al. Awake craniotomy to maximize glioma resection: methods and technical nuances over a 27-year period [J]. J Neurosurg, 2015, 123(2): 325-339.

[30] REHME A K, EICKHOFF S B, ROTTSCHY C, et al. Activation likelihood estimation meta-analysis of motor-related neural activity after stroke [J]. Neuroimage, 2012, 59(3): 2771-2782.

[31] DYM R J, BURNS J, FREEMAN K, et al. Is functional MR imaging assessment of hemispheric language dominance as good as the Wada test?: a meta-analysis [J]. Radiology, 2011, 261(2): 446-455.

[32] GIUSSANI C, ROUX F E, OJEMANN J, et al. Is preoperative functional magnetic resonance imaging reliable for language areas mapping in brain tumor surgery? Review of language functional magnetic resonance imaging and direct cortical stimulation correlation studies [J]. Neurosurgery, 2010, 66(1): 113-120.

[33] LI S W, WANG J F, JIANG T, et al. Preoperative 3T high field blood oxygen level dependent functional magnetic resonance imaging for glioma involving sensory cortical areas [J]. Chin Med J (Engl), 2010, 123(8): 1006-1010.

[34] ZHANG D, JOHNSTON J M, FOX M D, et al. Preoperative sensorimotor mapping in brain tumor patients using spontaneous fluctuations in neuronal activity imaged with functional magnetic resonance imaging: initial experience [J]. Neurosurgery, 2009, 65(6 Suppl): 226-236.

[35] JINGSHAN L, SHENGYU F, XING F, et al. Morphometry of the hand knob region and motor function change in eloquent area glioma patients [J]. Clin Neuroradiol, 2018, doi:10.1007/S00062-017-0659-8.

[36] MOLLER M, FREUND M, GREINER C, et al. Real time fMRI: a tool for the routine presurgical localisation of the motor cortex [J]. Eur Radiol, 2005, 15(2): 292-295.

[37] OTTE W M, VAN EIJSDEN P, SANDER J W, et al. A meta-analysis of white matter changes in temporal lobe epilepsy as studied with diffusion tensor imaging [J]. Epilepsia, 2012, 53(4): 659-667.

[38] van EWIJK H, HESLENFELD D J, ZWIERS M P, et al. Diffusion tensor imaging in attention deficit/hyperactivity disorder: a systematic review and meta-analysis [J]. Neurosci Biobehav Rev, 2012, 36(4): 1093-1106.

[39] BAI H M, WANG W M, LI T D, et al. Three core techniques in surgery of neuroepithelial tumors in eloquent areas: awake anaesthesia, intraoperative direct electrical stimulation and ultrasonography [J]. Chin Med J (Engl), 2011, 124(19): 3035-3041.

[40] 王伟民, 白红民, 李天栋, 等. 脑功能区胶质瘤手术中的新技术 [J]. 中华神经外科杂志, 2007, 23(6): 428-431.

[41] DUFFAU H, GATIGNOL P, MANDONNET E, et al. New insights into the anatomo-functional connectivity of the semantic system: a study using cortico-subcortical electro-stimulations [J]. Brain, 2005, 128(Pt 4): 797-810.

[42] SANAI N, MIRZADEH Z, BERGER M S. Functional outcome after language mapping for glioma resection [J]. N Engl J Med, 2008, 358(1): 18-27.

[43] 王伟民, 施冲, 李天栋, 等. 术中全麻唤醒下定位切除脑功能区病变(附 5 例报告) [J]. 中国微侵袭神经外科杂志, 2003, 8(6): 245-249.

[44] BILOTTA F, ROSA G. 'Anesthesia' for awake neurosurgery [J]. Curr Opin Anaesthesiol, 2009, 22(5): 560-565.

[45] SACKO O, LAUWERS-CANCES V, BRAUGE D, et al. Awake craniotomy vs surgery under general anesthesia for resection of supratentorial lesions [J]. Neurosurgery, 2011, 68(5): 1192-1199.

[46] PICCIONI F, FANZIO M. Management of anesthesia in awake craniotomy [J]. Minerva Anestesiol, 2008, 74(7-8): 393-408.

[47] 陈新忠, 王保国, 康孝荣, 等. 大脑皮质功能区手术唤醒试验中异丙酚复合舒芬太尼或瑞芬太尼麻醉的效果 [J]. 中华麻醉学杂志, 2006, 26(9): 813-817.

[48] DU G, ZHOU L, MAO Y. Neuronavigator-guided glioma surgery [J]. Chin Med J (Engl), 2003, 116(10): 1484-1487.

[49] SENFT C, BINK A, FRANZ K, et al. Intraoperative MRI guidance and extent of resection in glioma surgery: a randomised, controlled trial [J]. Lancet Oncol, 2011, 12 (11): 997-1003.

[50] KUBBEN P L, TER MEULEN K J, SCHIJNS O E, et al. Intraoperative MRI-guided resection of glioblastoma multiforme: a systematic review[J]. Lancet Oncol, 2011, 12 (11): 1062-1070.

[51] GOEBEL S, NABAVI A, SCHUBERT S, et al. Patient perception of combined awake brain tumor surgery and intraoperative 1.5-T magnetic resonance imaging: the Kiel experience [J]. Neurosurgery, 2010, 67(3): 594-600.

[52] LEUTHARDT E C, LIM C C, SHAH M N, et al. Use of movable high-field-strength intraoperative magnetic resonance imaging with awake craniotomies for resection of gliomas: preliminary experience[J]. Neurosurgery, 2011, 69(1): 194-206.

[53] NABAVI A, GOEBEL S, DOERNER L, et al. Awake craniotomy and intraoperative magnetic resonance imaging: patient selection, preparation, and technique [J]. Top Magn Reson Imaging, 2009, 19(4): 191-196.

[54] LU J, WU J, YAO C, et al. Awake language mapping and 3-Tesla intraoperative MRI-guided volumetric resection for gliomas in language areas [J]. J Clin Neurosci, 2013, 20(9): 1280-1287.

[55] WEINGARTEN D M, ASTHAGIRI A R, BUTMAN J A, et al. Cortical mapping and frameless stereotactic navigation in the high-field intraoperative magnetic resonance imaging suite [J]. J Neurosurg, 2009, 111(6): 1185-1190.

[56] 路俊锋, 章捷, 吴劲松, 等. 3.0T 术中磁共振成像引导下唤醒麻醉联合术中语言皮质定位技术在语言区脑胶质瘤手术中的应用 [J]. 中华外科杂志, 2011, 49(8): 693-698.

[57] 江涛, 陈新忠, 谢坚, 等. 功能区胶质瘤的术中直接电刺激判断核心手术技术 [J]. 中国微侵袭神经外科杂志, 2005, 10(4): 148-150.

[58] 白红民, 王伟民, 李天栋, 等. 术中直接电刺激在功能区病变手术中的应用(附 86 例分析) [J]. 中国微侵袭神经外科杂志, 2009, 14(7): 289-291.

[59] 白红民, 王伟民, 李天栋, 等. 应用术中直接电刺激最大安全切除功能区胶质瘤 [J]. 中华神经外科杂志, 2012, 28 (12): 1210-1214.

[60] MANDONNET E, WINKLER P A, DUFFAU H. Direct electrical stimulation as an input gate into brain functional networks: principles, advantages and limitations [J]. Acta Neurochir (Wien), 2010, 152(2): 185-193.

[61] DESMURGET M, REILLY K T, RICHARD N, et al. Movement intention after parietal cortex stimulation in humans [J]. Science, 2009, 324(5928): 811-813.

[62] BELLO L, GALLUCCI M, FAVA M, et al. Intraoperative subcortical language tract mapping guides surgical removal of gliomas involving speech areas [J]. Neurosurgery, 2007, 60(1): 67-82.

[63] SMITH J S, CHANG E F, LAMBORN K R, et al. Role of extent of resection in the long-term outcome of low-grade hemispheric gliomas [J]. J Clin Oncol, 2008, 26(8): 1338-1345.

[64] DUFFAU H. Surgery of low-grade gliomas: towards a 'functional neurooncology' [J]. Curr Opin Oncol, 2009, 21(6): 543-549.

[65] PETROVICH BRENNAN N M, WHALEN S, DE MORALES BRANCO D, et al. Object naming is a more sensitive measure of speech localization than number counting: Converging evidence from direct cortical stimulation and fMRI [J]. Neuroimage, 2007, 37(Suppl 1): 100-108.

[66] LUBRANO V, DRAPER L, ROUX F E. What makes surgical tumor resection feasible in Broca's area? Insights into intraoperative brain mapping [J]. Neurosurgery, 2010, 66(5): 868-875.

[67] 高寒, 王丽敏, 白红民, 等. 粤语–普通话双语者语言功能区定位研究 [J]. 中国微侵袭神经外科杂志, 2013, 18(5): 197-200.

[68] KIM S S, MCCUTCHEON I E, SUKI D, et al. Awake craniotomy for brain tumors near eloquent cortex: correlation of intraoperative cortical mapping with neurological outcomes in 309 consecutive patients [J]. Neurosurgery, 2009, 64(5): 836-845, 345-346.

[69] DE BENEDICTIS A, MORITZ-GASSER S, DUFFAU H. Awake mapping optimizes the extent of resection for low-grade gliomas in eloquent areas [J]. Neurosurgery, 2010, 66(6): 1074-1084.

[70] TALACCHI A, TURAZZI S, LOCATELLI F, et al. Surgical treatment of high-grade gliomas in motor areas. The impact of different supportive technologies: a 171-patient series [J]. J Neurooncol, 2010, 100(3): 417-426.

[71] CHOI B D, MEHTA A I, BATICH K A, et al. The use of motor mapping to aid resection of eloquent gliomas [J]. Neurosurg Clin N Am, 2012, 23(2): 215-225.

[72] 高寒, 白红民, 韩立新, 等. 汉–英非熟练晚双语者语言区定位研究 [J]. 中华外科杂志, 2013, 51(11): 1021-1024.

[73] DUFFAU H. Awake surgery for nonlanguage mapping [J]. Neurosurgery, 2010, 66(3): 523-529.

[74] ROUX F E, DUFOR O, LAUWERS-CANCES V, et al. Electrostimulation mapping of spatial neglect [J]. Neurosurgery, 2011, 69(6): 1218-1231.

[75] ILMBERGER J, RUGE M, KRETH F W, et al. Intraoperative mapping of language functions: a longitudinal neurolinguistic analysis [J]. J Neurosurg, 2008, 109(4): 583-592.

[76] DUFFAU H, CAPELLE L, SICHEZ N, et al. Intraoperative mapping of the subcortical language pathways using direct stimulations. An anatomo-functional study [J]. Brain, 2002,

125(Pt 1): 199-214.

[77] SANAI N, BERGER M S. Glioma extent of resection and its impact on patient outcome [J]. Neurosurgery, 2008, 62(4): 753-764, 264-266.

[78] SANAI N, BERGER M S. Operative techniques for gliomas and the value of extent of resection [J]. Neurotherapeutics, 2009, 6(3): 478-486.

[79] ZHANG Z, JIANG T, XIE J, et al. Surgical strategies for glioma involving language areas [J]. Chin Med J (Engl), 2008, 121(18): 1800-1805.

[80] BORCHERS S, HIMMELBACH M, LOGOTHETIS N, et al. Direct electrical stimulation of human cortex - the gold standard for mapping brain functions [J]? Nat Rev Neurosci, 2011, 13(1): 63-70.

[81] DUFFAU H, GATIGNOL P, MANDONNET E, et al. New insights into the anatomo-functional connectivity of the semantic system: a study using cortico-subcortical electro-stimulations [J]. Brain, 2005, 128(Pt 4): 797-810.

[82] 白红民,王伟民,梁树杰,等. 脑功能区胶质瘤的现代手术策略 [J]. 临床神经外科杂志, 2011, 8(5): 245-248.

（收稿日期：2018–06–15）