

65 例颅内动-静脉畸形手术疗效及技术探讨

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【摘要】 目的 评价手术切除颅内动-静脉畸形的有效性和安全性,并探讨手术技巧。方法 65 例颅内动-静脉畸形患者,Spetzler-Martin 分级 I 级 7 例、II 级 20 例、III 级 23 例、IV 级 10 例、V 级 5 例;畸形团最长径 2~7 cm,平均 3.50 cm;位于大脑皮质表面 31 例、脑深部 34 例,分别为额叶 19 例、颞叶 12 例、顶叶 16 例、枕叶 9 例、小脑 3 例、基底节 2 例、侧裂 4 例;供血动脉分别为大脑前动脉及分支 11 例、大脑中动脉 29 例、大脑后动脉 15 例、大脑前动脉和大脑中动脉 2 例,大脑前动脉和大脑后动脉 5 例,椎动脉 3 例;浅静脉引流 29 例、深静脉引流 15 例、深浅静脉同时引流 21 例。均予以手术切除,单纯畸形团切除术 45 例、畸形团切除术+血肿清除术 20 例;单纯额叶入路 6 例、眶颧部入路 3 例、皮质入路 2 例、额顶叶入路 8 例、翼点入路 10 例、颞下入路 3 例、颞顶叶入路 4 例、单纯顶叶入路 7 例、纵裂入路 7 例、顶枕叶入路 8 例、枕下入路 3 例、皮质脑室入路 4 例。**结果** 65 例患者中 4 例(6.15%)术前联合栓塞治疗,其中 60 例(92.31%)动-静脉畸形团全切除,5 例(7.69%)于术后辅助立体定向放射治疗。出院时改良 Rankin 量表评分为 0 分 21 例(32.31%)、1 分 23 例(35.38%)、2 分 9 例(13.85%)、3 分 7 例(10.77%)、4 分 3 例(4.62%)、5 分 2 例(3.08%)。平均随访 12 个月,6 例恢复良好、3 例肢体活动障碍、1 例视野缺损、2 例语言障碍、1 例脑积水而行脑室-腹腔分流术、2 例仍癫痫发作而服用抗癫痫药物;2 例死亡,1 例呼吸衰竭致死亡,1 例死因不明。**结论** 显微外科手术可有效治疗颅内动-静脉畸形,尤其是复杂动-静脉畸形,实施个体化治疗方案可有效改善患者预后。

【关键词】 动静脉畸形; 显微外科手术

Curative effect and surgical techniques of microsurgery for cerebral arteriovenous malformation: a report of 65 cases

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【Abstract】 Objective To assess the safety and efficacy of microsurgical resection of cerebral arteriovenous malformation (AVM). **Methods** A total of 65 patients with cerebral AVMs were treated with microsurgical resections from April to August 2010 in our hospital. Of the 65 patients, 26 were male and 39 were female with age ranging from 4 to 72 years (average 42 years). Initial symptoms included cerebral hemorrhage in 32 cases, seizures in 10 cases, headache in 6 cases, neurological dysfunction in 14 cases, and the left 3 cases were diagnosed in health examination. According to Spetzler-Martin grades, there were 7 cases in Grade I, 20 in Grade II, 23 in Grade III, 10 in Grade IV and 5 in Grade V. The diameter of nidi ranged from 2 to 7 cm (on average of 3.50 cm). The lesions were located in the surface of cerebral cortex (31 cases) and deep brain (34 cases), including frontal lobe (19 cases), temporal lobe (12 cases), parietal lobe (16 cases), occipital lobe (9 cases), cerebellum (3 cases), basal ganglia (2 cases) and lateral cleft (4 cases). Feeding arteries included anterior cerebral artery (ACA) and its branches in 11 cases, middle cerebral artery (MCA) in 29 cases, posterior cerebral artery (PCA) in 15 cases, both ACA and MCA in 2 cases, both ACA and PCA in 5 cases, and vertebral artery (VA) in 3 cases. There were superficial vein drainage in 29 cases, deep vein drainage in 15 cases, and both superficial and deep vein drainage in 21 cases. All of those patients underwent surgical resections, including simple excisions in 45 cases and excisions combined with evacuation of hematoma in 20 cases. Among all of those operations, 6 were

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performed through single-frontal approach, 3 orbitozygomatic approach, 2 transcortical approach, 8 frontal-parietal approach, 10 pterional approach, 3 subtemporal approach, 4 temporal-parietal approach, 7 single-parietal approach, 7 interhemispheric approach, 8 parietal-occipital approach, 3 suboccipital approach, and 4 transcortical-transventricular approach. **Results** Among these patients, 4 cases (6.15%) had undergone prior endovascular embolization. Total resection was obtained in 60 cases (92.31%) and 5 cases (7.69%) took postoperative stereotactic radiosurgery. On discharge, modified Rankin Scale (mRS) scores were 0 in 21 cases (32.31%), 1 in 23 cases (35.38%), 2 in 9 cases (13.85%), 3 in 7 cases (10.77%), 4 in 3 cases (4.62%) and 5 in 2 cases (3.08%). During the follow-up (12 months on average), 6 patients got good recovery, while 3 patients presented with limb weakness, one visual field defect, 2 aphasia, one underwent ventriculoperitoneal shunt (VPS) due to hydrocephalus, 2 newly occurred seizures, and 2 deaths (one died of respiratory failure after one year, and the other was agnogenic). **Conclusions** Microsurgical resection of AVMs is highly efficient and can be undertaken with low rates of mortality. Adequate patient selection and careful preoperative planning are essential to improve the prognosis of patients with complicated AVM lesions.

【Key words】 Arteriovenous malformations; Microsurgery

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颅内动-静脉畸形(AVM)所致脑出血是神经外科病死率的重要来源,据统计,颅内动-静脉畸形年发病率为(1.12~1.42)/10万,其中38%~68%患者以脑出血为首发症状,第1年再出血率为6%~18%,而未行干预治疗者年出血率为2.10%~4.12%^[1]。同时,由于血流动力学改变,毛细血管重建盗血使正常脑组织萎缩,约27%的患者因动-静脉畸形团破裂出血和引流静脉扩张造成的占位效应而致癫痫发作^[2]。2014年,药物治疗未破裂脑动-静脉畸形优于手术试验(ARUBA)结果显示,对于未破裂的动-静脉畸形,药物治疗效果优于手术治疗^[3]。回顾分析解放军总医院神经外科2010年4-8月手术治疗的65例颅内动-静脉畸形患者的临床资料,以探讨手术治疗动-静脉畸形的安全性和有效性。

资料与方法

一、临床资料

共65例颅内动-静脉畸形患者,男性26例,女性39例;年龄4~72岁,平均为42岁;发病至入院时间1~64d,平均为15d;其中32例因脑出血急诊入院,10例以癫痫发作为首发症状,6例表现为头痛,14例呈神经功能障碍,3例体格检查时发现病变;入院时Glasgow昏迷量表(GCS)评分6~15分,平均11分;Spetzler-Martin(S-M)分级^[4-5] I级7例, II级20例, III级23例, IV级10例, V级5例(表1)。本组65例患者共有65个动-静脉畸形团,位于大脑皮质表面31例、脑深部34例,分别为额叶19例、颞叶12例、顶叶16例、枕叶9例、小脑3例、基底节2例、侧裂4例,

其中有7例畸形团跨越脑叶;供血动脉1~4支,分别为大脑前动脉及其分支供血11例、大脑中动脉供血29例、大脑后动脉供血15例、大脑前动脉和大脑中动脉同时供血2例,大脑前动脉和大脑后动脉同时供血5例,椎动脉供血3例;浅静脉引流29例、深静脉引流15例、深浅静脉同时引流21例;畸形团最长径2~7cm,平均3.50cm;血肿最大径2~6cm,平均3cm,其中4例破入脑室。所有患者术前均行脑血管造影检查,部分行CT和MRI检查。

二、治疗方法

本组有35例患者术前行fMRI检查,勾画病变范围,定位锥体束、弓形束、视放射和语言功能区,明确动-静脉畸形团及其供血动脉与皮质功能区和传导束间的关系,辅助选择手术入路,并提醒术中操作注意事项(图1)。据病变部位及其毗邻关系,选择不同手术入路切除动-静脉畸形团,单纯畸形团切除术45例、畸形团切除术+血肿清除术20例;单纯额叶入路6例、眶颧部入路3例、皮质入路2例、额顶叶入路8例、翼点入路10例、颞下入路3例、颞顶叶入路4例、单纯顶叶入路7例、纵裂入路7例、顶枕叶入路8例、枕下入路3例、皮质脑室入路4例。对于较复杂的动-静脉畸形,单纯显微外科手术不能达到满意疗效,必要时可联合术前栓塞和术后放射治疗。本组有3例额顶叶高流量动-静脉畸形患者分别栓塞大脑前动脉和大脑中动脉分支,1例合并动脉瘤患者栓塞畸形团供血动脉近端动脉瘤。本组有5例患者术后畸形团残留,最长径均<3cm,辅助立体定向放射治疗,1例畸形团位置较深,4例畸形

表 1 65 例颅内动-静脉畸形患者 Spetzler-Martin 分级标准^[4-5] [例(%)]**Table 1.** Spetzler-Martin grades of 65 patients with AVMs^[4-5] [case (%)]

Spetzler-Martin	No. of subjects
Size	
Small (<3 cm)	35 (53.85)
Medium (3-6 cm)	24 (36.92)
Large (>6 cm)	6 (9.23)
Location	
Non-eloquent area	27 (41.54)
Eloquent area	38 (58.46)
Venous drainage	
Superficial	31 (47.69)
Deep	34 (52.31)
Grade	
I	7 (10.77)
II	20 (30.77)
III ⁻	7 (10.77)
III	10 (15.38)
III ⁺	6 (9.23)
IV	10 (15.38)
V	5 (7.69)
Total	65 (100.00)

团位于皮质功能区,其中 2 例毗邻内囊、1 例毗邻视放射、1 例位于语言功能区。术后辅助立体定向放射治疗,可精确定位靶点和放射治疗体积,采用多次分割放射治疗以减少对周围组织的损伤。

所有患者术后常规进入神经科重症监护病房(NICU),复查 CT,监测血压、凝血功能,预防癫痫发作和术区出血,必要时补充血浆或凝血因子,以及处理静脉血栓形成引起的脑水肿,待清醒、病情稳定后行脑血管造影检查。

三、预后评价

出院时采用改良 Rankin 量表(mRS)评价患者预后:0 分,完全无症状;1 分,有临床症状,但无神经功能障碍,能够完成所有工作和生活;2 分,轻残,不能完成所有工作和活动,但生活能够自理;3 分,中残,部分生活需他人帮助,但能够独立行走;4,中至重残,不能行走,生活需要他人帮助;5 分,重残,卧床,大小便失禁,生活完全依赖他人。

随访期间观察患者是否出现肢体活动障碍、语言障碍、视野缺损、癫痫发作等神经功能缺损症状,采用 Glasgow 预后分级(GOS)评价患者预后:5 分,

恢复良好,能够正常工作和学习;4 分,恢复中等,生活能够自理;3 分,重残,生活不能自理;2 分,植物状态生存;1 分,死亡。

结 果

本组 65 例患者中 60 例(92.31%)动-静脉畸形团全切除;5 例(7.69%)畸形团残留,术后辅助立体定向放射治疗。住院 5~32 d、平均 8 d,出院时 mRS 评分 0 分 21 例(32.31%)、1 分 23 例(35.38%)、2 分 9 例(13.85%)、3 分 7 例(10.77%)、4 分 3 例(4.62%)、5 分 2 例(3.08%),不同 Spetzler-Martin 分级患者预后情况参见表 2;随访 3~36 个月、平均 2 个月,GOS 评分 5 分 53 例(81.54%)、4 分 8 例(12.31%)、3 分 3 例(4.62%)、1 分 2 例(3.08%)。3 例肢体活动障碍,2 例为额顶叶入路、1 例为纵裂入路;1 例视野缺损,为单纯枕叶入路;2 例语言障碍,均为颞顶叶入路;1 例术中经顶叶皮质行脑室血肿清除术患者,术后 8 个月复查 MRI 发现脑积水,行脑室-腹腔分流术。10 例术前癫痫发作患者,6 例术后发作停止、4 例口服抗癫痫药物控制良好(图 1);53 例术前无癫痫发作患者,术后均口服抗癫痫药物,2 例出现癫痫发作,1 例为颞下入路、1 例为额颞叶入路,继续服用抗癫痫药物,余均未出现癫痫发作;2 例死亡,1 例于术后 12 个月呼吸衰竭致死亡,1 例于术后 18 个月死亡、原因不明。

讨 论

关于颅内动-静脉畸形治疗方案的选择,ARUBA 试验公布的单纯药物治疗优于手术治疗的结果极具争议。Amin-Hanjani^[6]认为该项试验设计有偏倚,其结论不完全可靠。由于每例患者病变特点不同、基础生理状态不同,畸形团破裂出血发生率应具体分析^[7]。颅内动-静脉畸形年出血率可达 4%,据文献报道,颅内动-静脉畸形破裂出血病死率和病残率高达 10%^[1],Spetzler-Martin 分级 I~II 级者手术满意率达 95%~100%^[8],即使是无症状患者也建议积极行手术治疗;术中应用 fMRI 和吲哚菁绿荧光血管造影(ICGA),可使大部分 III 级患者同样获得满意的手术效果^[4]。IV~V 级者手术风险相对较高,术前应仔细评估病变位置、大小、供血动脉与引流静脉管径比、是否单一深静脉引流、是否合并动脉瘤,以及血压、血糖、妊娠等的影响^[9],客观比较保

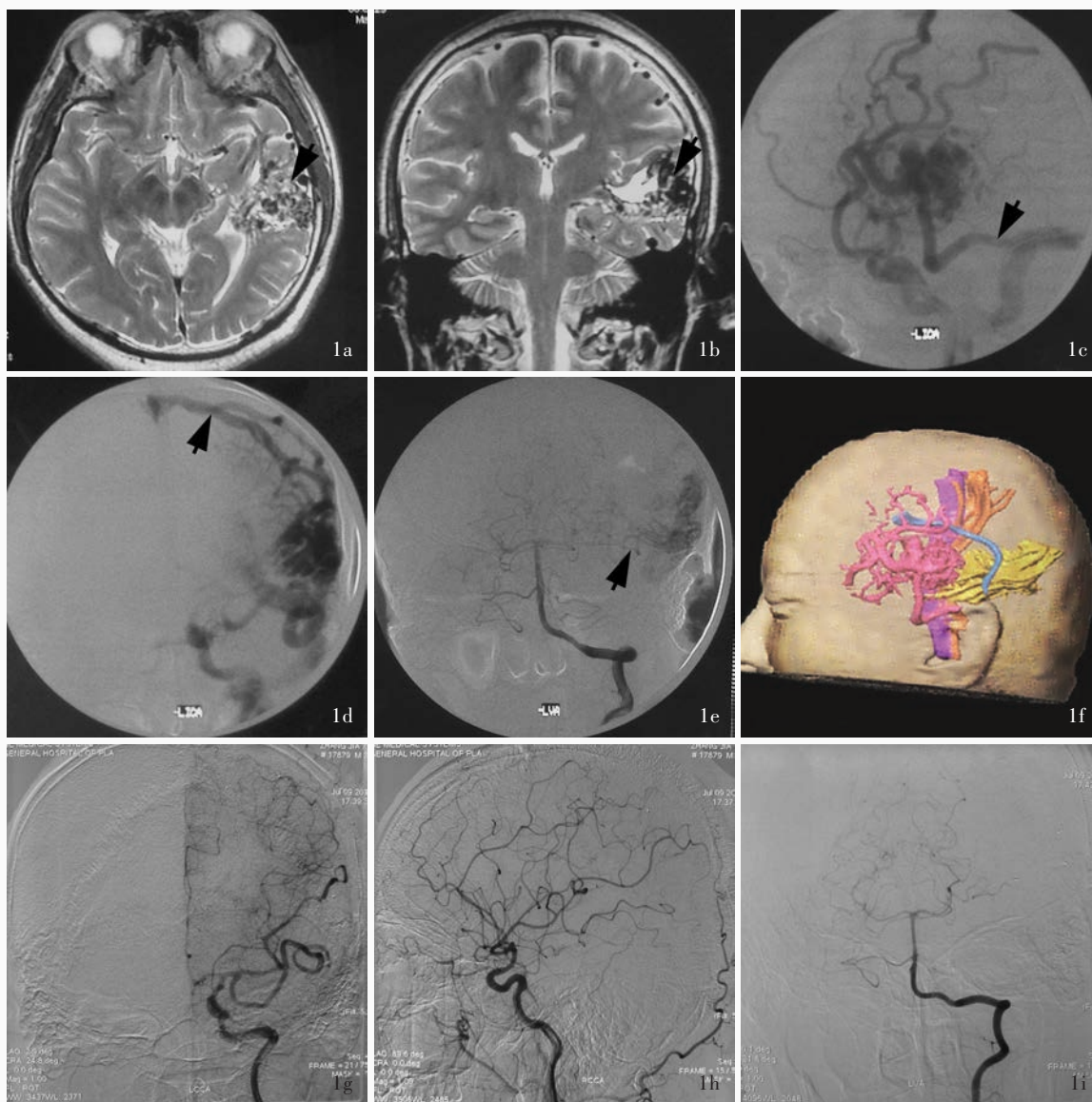


图 1 男性患者,30 岁,因反复癫痫发作 2 年入院。临床诊断为左侧颞叶动-静脉畸形(Spetzler-Martin 分级 IV 级),继发性癫痫。影像学检查和术中所见 1a 横断面 T₂WI 显示左侧颞叶大片混杂信号(箭头所示) 1b 冠状位 T₂WI 显示左侧颞叶大片混杂信号(箭头所示) 1c 左前斜位左侧颈内动脉造影显示,左侧大脑中动脉为供血动脉,畸形团最长径约 5.50 cm,引流入横窦(箭头所示) 1d 正位左侧颈内动脉造影显示,左侧大脑中动脉为供血动脉,畸形团引流入上矢状窦(箭头所示) 1e 正位左侧椎动脉造影显示,左侧大脑后动脉参与畸形团供血(箭头所示) 1f 术前 fMRI 定位锥体束(紫色和橙色所示)、弓形束(蓝色所示)、视放射(黄色所示)和语言功能区及其与畸形团的毗邻关系 1g~1i 术后复查脑血管造影,左侧大脑后动脉正常显影,未见畸形团

Figure 1 A 30-year-old male was admitted to hospital due to a 2-year history of recurring seizures. The clinical diagnosis was left temporal lobe AVM (Spetzler-Martin IV) and secondary epilepsy. The imaging examination and intraoperative findings. Preoperative axial T₂WI revealed large patches of mixed signals in left temporal lobe (arrow indicates, Panel 1a). Coronal T₂WI revealed large patches of mixed signals in left temporal lobe (arrow indicates, Panel 1b). Anterior oblique view of DSA revealed an AVM with a diameter of about 5.50 cm, and the venous drainage was to the transverse sinus (arrow indicates, Panel 1c). Anteroposterior view of DSA revealed the feeding artery was left MCA, and the nidus was drained to superior sagittal sinus (arrow indicates, Panel 1d). Anteroposterior view of DSA revealed the PCA supplied the nidus (arrow indicates, Panel 1e). Preoperative fMRI located the pyramidal tract (purple and orange areas indicate), arcuate fasciculus (blue areas indicate) and optic radiation (yellow areas indicate, Panel 1f). Postoperative DSA revealed the AVM was resected completely (Panel 1g). Lateral view (Panel 1h) and anteroposterior view (Panel 1i) of DSA revealed the blood perfusion of left PCA was normal, and the AVM disappeared.

守治疗与手术治疗的风险。研究显示,微小 RNA18a(miRNA18a)可调节血管内皮生长因子

(VEGF)表达变化,使脑血管结构趋于正常,未来有望静脉注射或血管内灌注 miRNA18a 以治疗动-静

表 2 不同 Spetzler-Martin 分级患者出院时改良 Rankin 量表评分 [例 (%)]

Table 2. mRS scores on discharge in patients with different Spetzler-Martin grades [case (%)]

mRS (score)	Spetzler-Martin					Total
	I	II	III	IV	V	
0	6 (9.23)	10 (15.38)	5 (7.69)	0 (0.00)	0 (0.00)	21 (32.31)
1	1 (1.54)	6 (9.23)	14 (21.54)	2 (3.08)	0 (0.00)	23 (35.38)
2	0 (0.00)	3 (4.62)	2 (3.08)	4 (6.15)	0 (0.00)	9 (13.85)
3	0 (0.00)	1 (1.54)	2 (3.08)	3 (4.62)	1 (1.54)	7 (10.77)
4	0 (0.00)	0 (0.00)	0 (0.00)	1 (1.54)	2 (3.08)	3 (4.62)
5	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (3.08)	2 (3.08)
Total	7 (10.77)	20 (30.77)	23 (35.38)	10 (15.38)	5 (7.69)	65 (100.00)

mRS, modified Rankin Scale, 改良 Rankin 量表

脉畸形^[10];也有文献报道,四环素类抗生素可以抑制畸形血管的异化过程,降低出血风险^[11]。

颅内动-静脉畸形位置、大小、供血动脉、引流静脉及其与皮质功能区的毗邻关系决定手术入路。幕上病变大致包括大脑皮质表面、脑深部、颅底、脑室旁,同时需考虑其与侧裂和纵裂的关系。额叶表面病变采用单纯额叶入路即可到达病变部位,易操作。侧裂周围和岛叶病变可经翼点-侧裂入路到达,术中须仔细分离侧裂血管,必要时可临时阻断大脑中动脉予以鉴别^[12]。顶叶和枕叶表面病变则选择顶枕叶入路。脑表面动-静脉畸形毗邻皮质功能区时,多于皮质表面仅见数条引流静脉,而供血动脉在脑深部,若直接探查分离供血动脉,易造成皮质功能区损伤,可先电灼远离皮质功能区的次要引流静脉,再沿神经胶质增生带分离畸形团,最后深入探查供血动脉^[13]。

约 18% 的患者合并动脉瘤,此时发生颅内出血的风险更高,年出血率约 9.70%^[1]。二者的位置关系包括:动脉瘤与畸形团无直接关系(I型)、动脉瘤位于畸形团供血动脉近端(II型)、动脉瘤位于畸形团供血动脉远端(III型)、动脉瘤位于畸形团内(IV型)。有文献报道,43%的动脉瘤与畸形团无直接关系,37%的动脉瘤位于畸形团主要供血动脉主干。关于动-静脉畸形合并动脉瘤的治疗策略一直存有争议^[14],ARUBA 试验显示,对于无颅内出血史的颅内动-静脉畸形患者,药物保守治疗较手术治疗的并发症更少且更安全。Flores 等^[15]建议,首先处理与临床症状相关的病变,若无颅内出血,I型和IIa型者优先处理动脉瘤,IIb型和III型者以畸形团

为主,若能同时处理两种病变,尽可能一次完成。立体定向放射治疗应在处理动脉瘤后进行。

手术治疗、血管内介入治疗、立体定向放射治疗的切除率分别为 96%、13% 和 38%^[16]。后两者为分阶段治疗,逐步缩小病变范围和体积,但可因血流动力学改变,使血管内皮生长因子表达水平升高,血管内皮分化,更易破裂。手术切除仍是颅内动-静脉畸形的主要治疗方法,清晰和优化手术入路的选择显得尤为重要。显微外科手术可以直接切除畸形团,是最直接、最彻底的治疗方法。我们的临床体会是:(1)术前仔细筛查和评估可以减少术中出血和心肌梗死发生率。(2)手术体位摆放应确保颈静脉回流通畅,适当抬高头位、减少静脉回流以降低畸形团表面张力。我们在临床实践中曾遇到 1 例患者因手术体位需要,头部过伸,颈静脉怒张,去骨瓣后硬脑膜张力增高,只能通过预留的腰大池引流和输注甘露醇以降低颅内压。(3)有供血动脉或小分支供应周围皮质功能区,应分离至畸形团近端,勿过早夹闭。管径较大的供血动脉可先临时夹闭再电凝,防止破裂出血。(4)若供血动脉相对细小,管壁硬化,电凝止血欠佳,连同小部分脑组织一起烧灼,可有效止血^[17]。务必全切除畸形团,如果有残留,不仅不能改变动-静脉畸形的自然进程,甚至可能会因血流动力学改变而具有高出血风险,因此术前仔细辨认患者血管组成尤为重要。(5)术前发生脑出血患者,术中充分利用血肿腔,将对脑组织的干扰和损伤降至最低。(6)位于脑深部或毗邻皮质功能区的动-静脉畸形,应结合 fMRI 选择手术入路和确定切除范围,遵循距离最近、操作方便、尽量避开皮质功能区的原则。只要严格按照边界分离畸形团,大部分神经功能均可恢复,甚至无明显损伤。(7)对于复杂的多个巨大动-静脉畸形,脑血管发生继发性改变、畸形团周围皮质萎缩、皮质功能区缩小、部分皮质功能区移位,可部分或完全避免术后失语、感觉障碍、偏瘫、偏盲等神经功能缺损。位于脑深部或毗邻皮质功能区的动-静脉畸形,可因电凝使引流静脉血栓移位而堵塞正常引流静脉,从而引起脑水肿,在确保残留部分引流通畅的情况下,可行立体定向放射治疗^[18]。

患者的筛选和治疗策略(药物治疗、手术治疗、血管内介入治疗、立体定向放射治疗或多种方法相结合)的选择至关重要,谨慎评估疾病自然进程和治疗风险,选择个体化治疗方案,能够有效保证颅

内动-静脉畸形患者的良好预后。

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· 小 词 典 ·

中英文对照名词词汇(五)

T细胞受体 T cell receptor(TCR)

下丘脑-垂体-肾上腺 hypothalamic pituitary adrenal(HPA)

28项一般健康问卷

General Health Questionnaire-28(GHQ-28)

心脏事件预防评价研究-2

Heart Outcomes Prevention Evaluation-2(HOPE-2)

新型口服抗凝药 new oral anticoagulants(NOACs)

选择性5-羟色胺再摄取抑制剂

selective serotonin reuptake inhibitor(SSRI)

血管紧张素 II 受体阻断剂

angiotensin receptor blocker(ARB)

血管紧张素转换酶抑制剂

angiotensin converting enzyme inhibitor(ACEI)

血管内皮生长因子

vascular endothelial growth factor(VEGF)

血栓素 A₂ thromboxane A₂(TXA₂)

血氧水平依赖性功能磁共振成像

blood oxygenation level-dependent functional magnetic resonance imaging(BOLD-fMRI)

药物治疗未破裂脑动-静脉畸形优于手术试验

Medical Management with or without Interventional Therapy for Unruptured Brain Arteriovenous Malformations (ARUBA) trial

医院焦虑抑郁量表

Hospital Anxiety and Depression Scale(HADS)

乙二胺四乙酸 ethylenediaminetetraacetic acid(EDTA)