

· 论 著 ·

硬通道穿刺引流术联合脑膜中动脉栓塞治疗合并
高危复发因素的慢性硬膜下血肿

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【摘要】目的 探讨硬通道穿刺引流术联合脑膜中动脉(MMA)栓塞治疗含高危复发因素的慢性硬膜下血肿(CSDH)的安全性及有效性。方法 回顾性分析 2021 年 1 月至 2023 年 4 月手术治疗的 22 例含高危复发因素的 CSDH 的临床资料。所有病人均采用硬通道穿刺引流术联合 MMA 栓塞治疗。结果 栓塞方法:单纯 EVAL 胶栓塞 13 例,单纯弹簧圈栓塞 2 例,EVAL 胶联合弹簧圈栓塞 7 例;双侧栓塞 9 例。术后 CT 复查显示血肿腔内密度增高 9 例。所有病人术后临床症状均缓解。22 例术后随访 3 个月未见血肿进展、复发。结论 硬通道穿刺引流术联合 MMA 栓塞是治疗 CSDH 的有效手段之一,远期疗效有待进一步观察。

【关键词】慢性硬膜下血肿;脑膜中动脉栓塞;硬通道穿刺引流术;安全性;有效性

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Safety and effectiveness of hard channel puncture and drainage combined with middle meningeal artery embolization for chronic subdural hematomas with high-risk recurrence factors

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【Abstract】Objective To investigate the safety and efficacy of hard-channel puncture and drainage combined with middle meningeal artery (MMA) embolization for chronic subdural hematomas (CSDHs) with high-risk recurrence factors. Methods The clinical data of 22 patients with CSDHs associated with high-risk recurrence factors who underwent hard-channel puncture and drainage combined with MMA embolization from January 2021 to April 2023 were retrospectively analyzed. Results Regarding the embolization methods, 13 patients received pure EVAL glue embolization, 2 received pure coil embolization, and 7 received a combination of EVAL glue and coil embolization; among them, 9 patients underwent bilateral embolization. Postoperative CT reexamination indicated that the density within the hematoma cavity increased in 9 patients. All patients' clinical symptoms were alleviated after the operation. No hematoma progression or recurrence was observed during the 3-month follow-up. Conclusion Hard-channel puncture and drainage combined with MMA embolization is one of the effective approaches for treating CSDH associated with high-risk recurrence factors, but its long-term therapeutic effect still requires further observation.

【Key words】Chronic subdural hematoma; High-risk recurrence factors; Middle meningeal artery; Embolization; Hard-channel puncture and drainage; Safety; Efficacy

慢性硬膜下血肿(chronic subdural hematoma, CSDH)是神经外科常见疾病之一,其生理病理过程是桥静脉破裂出血后,硬膜下腔内缓慢积血、促炎因子诱导、血液降解产物生成、高渗透性毛细血管出现,从而形成血肿包膜慢性渗血^[1];也可由慢性硬膜下积液转变而来^[2]。传统的钻孔引流术存在较高的复发概率。研究发现,脑膜中动脉(middle meningeal artery, MMA)供应的小动脉参与了 CSDH 的形成及复发^[3]。神经内镜治疗 CSDH 术中发现血

肿腔内新生毛细血管伴渗血^[4]。这给血管内栓塞治疗 CSDH 及降低复发概率提供了理论支持^[1,5]。本文探讨硬通道穿刺引流术联合 MMA 栓塞治疗含高危复发因素的 CSDH 的安全性及有效性。

1 资料与方法

1.1 病例选择标准 纳入标准:CT 明确诊断 CSDH;影像学可见脑组织受压明显,或有一定的神经功能障碍;包含 3 项或以上以下高危复发因素^[1,2]:高龄(>65 岁)、脑萎缩、中线移位>1 cm、血肿厚度>2 cm、双侧硬膜下血肿、糖尿病、肝功能不全/出凝血功能障碍、复发性 CSDH、血肿内混合密度、接受抗凝抗板治疗、高 Markwalder's 评级、血液透析/肿瘤病史、血肿腔内存在分隔、术后脑组织复张不良/残留较多、影

像学示 MMA 增粗。排除标准:影像学检查显示血肿厚度<1 cm,无明显临床症状;存在严重肝肾功能异常,不能耐受手术治疗;病人或家属拒绝手术治疗。

1.2 研究对象 回顾性分析 2021 年 1 月至 2023 年 4 月手术治疗的 22 例含高危复发因素的 CSDH 的临床资料,其中男性 16 例,女性 6 例;年龄 52~88 岁,平均年龄(73.41±10.87)岁;有明确外伤病史 15 例;入院时神志清醒 6 例,嗜睡 12 例,朦胧 2 例。22 例均有头痛头晕,16 例出现肢体乏力等神经功能障碍。存在的高危因素见表 1。

1.3 治疗方法

1.3.1 硬通道穿刺引流术 取平卧位,头部偏向健侧,取患侧顶结节或血肿最厚部位为穿刺中心,采用一次性颅内血肿穿刺针(YL-1 型,规格 20 mm)穿刺后,侧管连接三通及引流袋。术后动态复查 CT,必要时可联合应用尿激酶,待大部分血肿引流后拔除硬通道。

1.3.2 MMA 栓塞 全麻后,用 Seldinger 法穿刺右侧股动脉并置入穿刺鞘。先行脑血管造影,完善双侧颈内动脉及颈外动脉正侧位造影,评估眼动脉起始情况,颈外动脉及 MMA 有无颅内“危险吻合”,有无异常跨中线 MMA 血供。然后,将 5F 或 6F 导引导管留置于患侧颈外动脉。微导管超选进入 MMA 主干,并行手推造影评估血管走行及颅内吻合情况,同时可见责任血管末端异常“棉絮状”染色显影,与硬膜下血肿范围一致。排除危险吻合,并明确岩支起

始位置,手推造影评估返流情况。使用 EVAL 胶栓塞,注胶同时逐步回退微导管,注意胶有无向眶内返流,待责任分支栓塞满意或胶水返流时拔除微导管。存在危险吻合、出血等情况时,采取单纯弹簧圈栓塞。若存在较大返流风险或责任分支管径较粗时,则尝试应用弹簧圈封堵责任血管起始处,应用“高压锅技术”注胶栓塞。术后再行脑血管造影评估颈外等血管情况,动态复查头颅 CT 明确有无再出血等情况。

1.4 评估指标

1.4.1 术前评估 术前采取 Markwalder 评级^[6]评估神经功能:0 级,无神经功能障碍;Ⅰ级,存在头痛头晕等症状,轻度神经功能障碍;Ⅱ级,神志嗜睡,存在轻偏瘫等神经功能障碍;Ⅲ级,神志朦胧/浅昏迷,偏瘫等严重的神经功能障碍;Ⅳ级,昏迷,去脑强直。

1.4.2 术后评估 术后及出院后动态复查 CT,如出院随访时出现血肿厚度增加或密度增高为复发,并关注有无新发神经功能障碍。

2 结果

2.1 治疗结果 术前 Markwalder 评级Ⅰ级 6 例,Ⅱ级 14 例,Ⅲ级 2 例;术后 Markwalder 评级Ⅰ级 3 例,其余 0 级。术后 Markwalder 评级较术前明显改善($Z=-5.833$; $P<0.001$)。术中发现颅内血管吻合 3 例,术后无视力、视野损害,无面瘫等神经损伤。术前造影均可见患侧 MMA 远端分支异常“棉絮状”染色显影,与术前 CT 病变范围相符。单纯 EVAL 胶栓塞 13 例,单纯弹簧圈栓塞 2 例,EVAL 胶联合弹簧圈栓塞 7 例;双侧栓塞 9 例。术后 1~6 h 复查 CT 见血肿腔内密度增高 9 例。1 例术中 MMA 额支血管夹层出血,予以弹簧圈栓塞额支主干后远端不显影,MMA 主干及岩支血管通畅,术后 CT 未见明显出血增加,随访 3 个月无神经功能障碍。

2.2 随访结果 术后 3 个月影像学随访,未见血肿复发(图 1、2);无新发神经功能障碍。

3 讨论

CSDH 传统的治疗方案包括钻孔引流术、神经内镜下血肿清除术、保守治疗等等。对于中线移位明显,或存在一定的神经功能障碍的病人,钻孔引流术仍为首选治疗方案。我们采取硬通道穿刺引流术,与传统钻孔手术相比,手术时间短,麻醉风险低,病人耐受程度良好,且该系统为密闭环境,发生张力性气颅等并发症概率较低^[5, 7]。但是,引流术后

表 1 慢性硬膜下血肿合并的高危复发因素
Table 1 High- risk recurrence factors associated with chronic subdural hematoma

| 复发高危因素 | 例数(例) |
|--------------------|------------|
| 高龄(>65 岁) | 18(81.82%) |
| 脑萎缩 | 14(63.64%) |
| 中线移位>1 cm | 5(22.73%) |
| 血肿厚度>2 cm | 18(81.82%) |
| 双侧硬膜下血肿 | 9(40.91%) |
| 糖尿病 | 3(13.64%) |
| 肝功能不全/出凝血功能障碍 | 4(18.18%) |
| 复发型硬膜下血肿 | 2(9.09%) |
| 血肿内混合密度 | 10(45.45%) |
| 接受抗凝抗板治疗 | 2(9.09%) |
| Markwalder's 评级≥Ⅱ级 | 16(72.73%) |
| 血液透析/肿瘤病史 | 2(9.09%) |
| 血肿腔内存在分隔 | 3(13.64%) |
| 术后脑组织复张不良/残留较多 | 10(45.45%) |
| 影像学示脑膜中动脉增粗 | 5(22.73%) |

CSDH 复发率较高,可达 9.2%~26.5%^[8]。研究表明,双侧 CSDH、血肿密度不均、腔内分隔、肿瘤病史、服用抗凝抗板药物、高龄、脑萎缩、不良 Markwalder's 分级等因素为 CSDH 复发高危因素^[4]。在 CSDH 复发及形成的过程中,MMA 占主要地位,由 MMA 供血的血肿包膜外新生的毛细血管脆性及渗透性高,易反复渗漏,从而导致血肿进展及复发^[1]。而 MMA 栓塞可以有效阻断 CSDH 新生毛细血管血供,也为治疗 CSDH、降低复发概率提供了新的思路。

本文 CSDH 病人存在较多的复发高危因素,术前造影可见典型“棉絮”状染色,术后短时间内复查 CT 可见血肿腔内密度较前增高,以上均为 MMA 栓塞治疗 CSDH 高危复发的有效证据。研究表明,MMA 栓塞治疗是降低 CSDH 复发率的手段之一^[9]。硬通道穿刺引流术有时难以充分引流,存在脑组织

复张不良等情况,此缺陷也可经 MMA 栓塞弥补。对于复发及难治型 CSDH,钻孔引流术联合 MMA 栓塞治疗也有一定的疗效^[10]。

由于血肿残余、血肿腔内多分隔等情况均与 CSDH 复发相关^[11],此类情况也存在 MMA 多分支参与,故优先挑选术前 CT 存在血肿残余的部位、术前 CT 积液量较厚的部位优先栓塞,以降低复发概率。研究发现,同时栓塞 MMA 远端 2 分支的病人,术后复发概率低于仅栓塞单支的病人^[12],故在排除危险吻合等情况下,术中需尽可能栓塞 MMA 远端多分支。Martinez 等^[13]发现,CSDH 患侧 MMA 平均直径大于健侧及健康人群,受 CSDH 病变累及后 MMA 血管直径往往增粗扩张,从而可成为术中超选的良好选择。优先选择走形平直及扩张的 MMA 分支优先进行超选及栓塞,手术难度较低,既可避免胶返流至

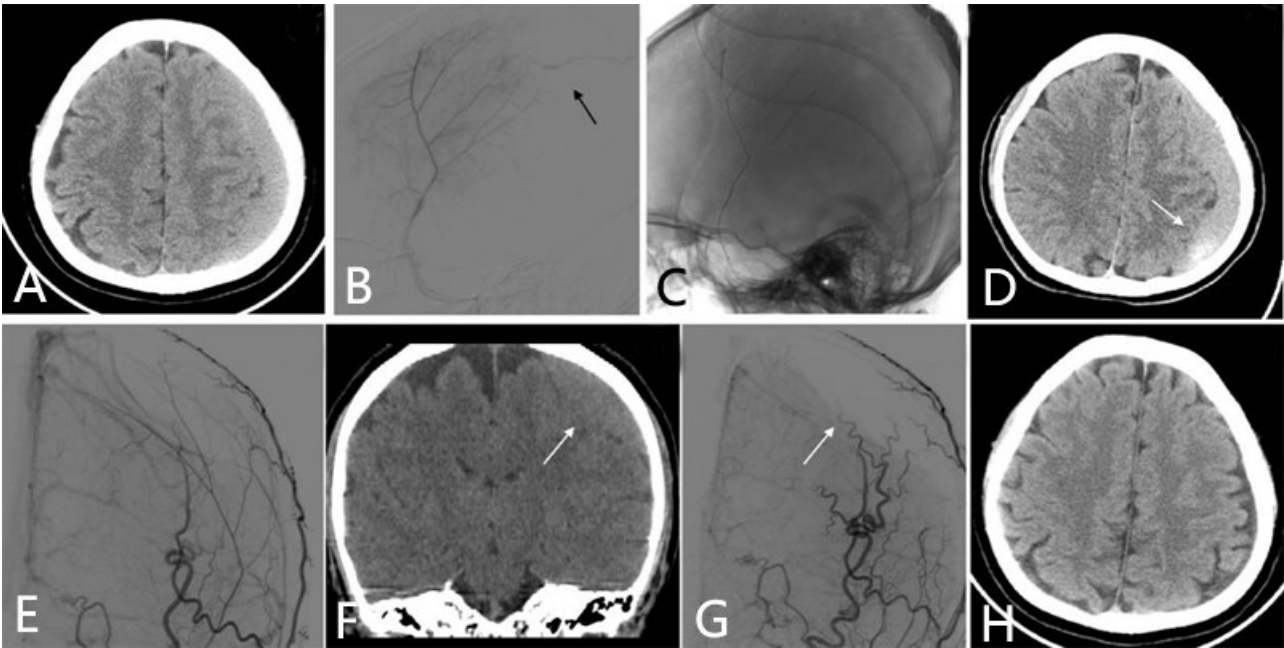


图1 慢性硬膜下血肿脑膜中动脉栓塞前后影像

A: 术前头颅 CT 示左额颞顶慢性硬膜下血肿;B: 术前 DSA 显示微导管超选进入左侧脑膜中动脉远端分支,造影可见“棉絮状”异常染色显影及静脉引流(↑示);C: 术后即刻骨窗图像可见栓塞剂的形态与术前脑膜中动脉走形相符;D: 术后 1 d 复查 CT 可见血肿腔内密度增高,血肿体积与术前相仿;E、F: 术中造影及冠状位 CT 可见血肿占位效应;G: 术后造影见脑膜中动脉不显影,脑组织受压情况与术前相仿,血肿形态未见明显变化;H: 术后 3 个月随访 CT 未见血肿复发

Figure 1 Preoperative and postoperative imaging findings of a patient with chronic subdural hematoma undergoing middle meningeal artery embolization

A: Preoperative CT reveals chronic subdural hematoma in the left frontal, temporal, and parietal regions. B: Preoperative DSA shows that the microcatheter is super-selectively inserted into the distal branch of the left middle meningeal artery, and "cotton-like" abnormal staining and venous drainage are observable (indicated by the arrow). C: The immediate postoperative bone window image indicates that the morphology of the embolic agent is consistent with the preoperative course of the middle meningeal artery. D: CT re-examination one day after the operation shows an increase in density within the hematoma cavity, and the hematoma volume is similar to that before the operation. E-F: Intraoperative angiography and coronal CT demonstrate the space-occupying effect of the hematoma. G: Postoperative angiography reveals no visualization of the middle meningeal artery; the compression of brain tissue is similar to that before the operation, and there is no obvious change in the morphology of the hematoma. H: CT follow-up at 3 months after the operation shows no recurrence of the hematoma.

MMA 主干,又可充分栓塞包膜中的微小动静脉血管,以降低CSDH的复发概率。

对于颅内外交通吻合、眼动脉异常起始等情况,术前需完善颈内动脉、颈外动脉造影,明确眼动脉等颅内血管解剖情况。本文3例存颅内外吻合,比例约13.6%。Fantoni等^[3]发现CSDH中约有13.8%的眼动脉起始于MMA,且眼动脉异常起始为CSDH形成

的高危因素之一。由于常用的Onxy胶等小分子液体栓塞剂存在一定的不可控性,一旦误入颈内外血管吻合等结构,可导致灾难性后果。目前,已有MMA栓塞后栓子返流移位致眼部疼痛、视力丧失的报道^[14]。其他常见并发症可能有周围性面瘫、头痛、舌咽神经麻痹等^[13]。此外,MMA岩支多为面神经滋养血管,术前也需格外注意。常规MMA造影中有部

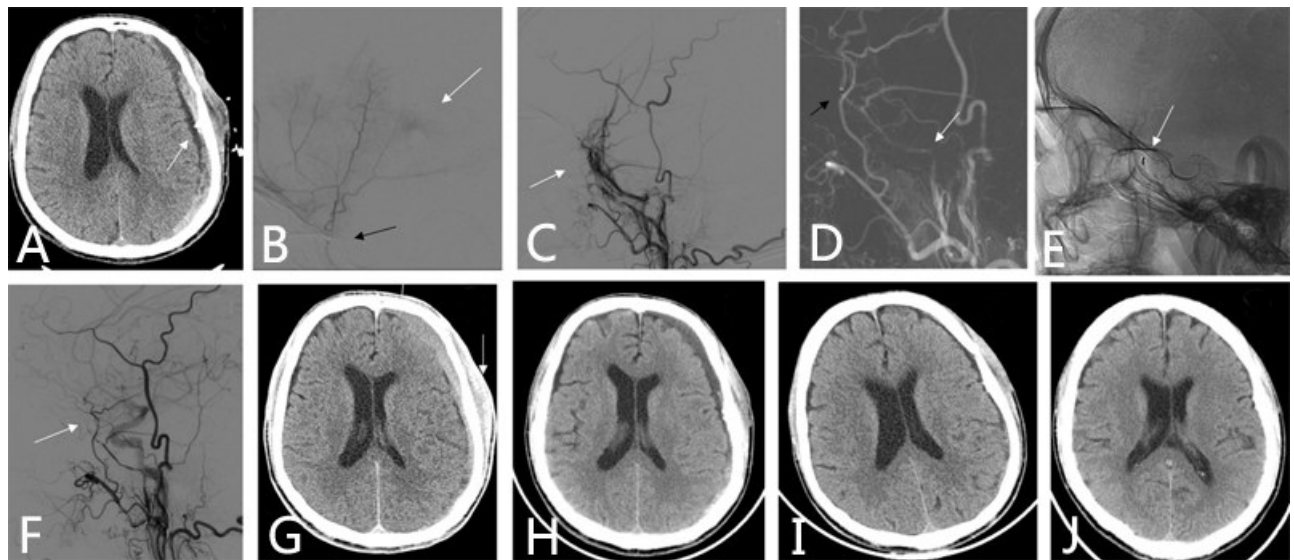


图2 慢性硬膜下血肿脑膜中动脉栓塞前后影像

A. 术前头部CT显示硬通道穿刺引流针(↑示),部分硬膜下血肿残留;B. 术中DSA显示微导管超选脑膜中动脉额支,黑色↑为微导管头端,造影可见远端“棉絮状”异常染色影(白色↑示);C. 术中DSA显示微导管超选远端分支推进困难,回撤微导管后中间导管内造影可见脑膜中动脉主干处异常血管影(白色↑示),考虑血管夹层渗出;D. 再次经微导丝超选推送微导管进入脑膜中动脉真腔,中间导管内路图可见正常血管走形,黑、白↑分别为微导管头尾端MARK点;E. 选择弹簧圈(白色↑示)栓塞脑膜中动脉额支主干;F. 术后造影见脑膜中动脉其余分支血流通畅,额支及以上不显影;G. 术后1d复查CT见额颞部硬膜下密度增高,颞肌密度增高(白色↑示),血肿腔大小与术前相仿,考虑造影剂入毛细血管渗出所致;H. 术后2d复查CT显示额颞部硬膜下血肿密度减退,颞肌密度减退,血肿腔大小仍较前相仿,考虑造影剂吸收;I、J. 术后3、6个月复查CT未见血肿复发,脑组织膨胀良好

Figure 2 Preoperative and postoperative imaging findings of a patient with chronic subdural hematoma undergoing middle meningeal artery embolization

A: Preoperative head CT reveals the hard-channel puncture and drainage needle (indicated by the arrow), with some residual subdural hematoma being observable. B: Intraoperative DSA demonstrates that the microcatheter is superselectively inserted into the frontal branch of the middle meningeal artery; the black arrow indicates the tip of the microcatheter, and the distal "cotton-like" abnormal staining shadow can be visualized on the angiogram (indicated by the white arrow). C: Intraoperative DSA indicates that the microcatheter encounters difficulty in advancing when superselectively entering the distal branch; after retracting the microcatheter, an abnormal vascular shadow at the main trunk of the middle meningeal artery can be seen on the angiogram within the intermediate catheter (indicated by the white arrow), suggesting vascular dissection and leakage. D: With the guidance of the microguidewire once again, the microcatheter is successfully superselectively placed in the true lumen of the middle meningeal artery; the roadmap within the intermediate catheter shows a normal vascular course; the black and white arrows respectively mark the MARK points at the head and tail ends of the microcatheter. E: The frontal branch of the middle meningeal artery is embolized using coils (indicated by the white arrow). F: The postoperative angiography reveals unobstructed blood flow in the other branches of the middle meningeal artery, while the frontal branch and above are not visualized. G: CT reexamination on the first day after the operation shows increased density in the subdural space of the frontal and temporal regions and increased density in the temporal muscle (indicated by the white arrow); the size of the hematoma cavity is similar to that before the operation, suggesting that the contrast agent has seeped into the capillaries. H: CT reexamination on the second day after the operation shows decreased density in the subdural hematoma of the frontal and temporal regions and decreased density in the temporal muscle; the size of the hematoma cavity remains similar to that before the operation, suggesting absorption of the contrast agent. I-J: CT reexaminations at 3 and 6 months after the operation show no recurrence of the hematoma and good expansion of the brain tissue.

分病例岩支难以显影的情况,但仍建议栓塞时将微导管头端越过颞骨岩部,必要时可采用“高压锅”技术避免返流。也可应用明胶海绵颗粒等大颗粒栓塞材料或弹簧圈栓塞,以避免误栓塞细小的吻合口。同时,研究表明应用不同栓塞材料治疗 CSDH,其治疗效果无统计学差异^[14]。

El Kim^[15]研究发现 MMA 栓塞联合钻孔引流术效果优于单纯钻孔引流术,栓塞后血肿吸收速度及脑组织复张速度较快,并发症发生率及复发率均较传统手术低。目前,有荟萃分析报道 MMA 栓塞术后复发率在 3.9%~5.5%^[16],低于传统手术的复发率。对于 CSDH,首次发病时即可评估复发风险因素,进行 MMA 栓塞以降低复发概率^[17]。但是,MMA 栓塞术后也存在一定的复发风险,其原因可能包括栓塞后血管再通、栓塞不完全、存在一定的解剖变异等等。Martinez 等^[13]发现同侧 MMA 栓塞术后复发,造影可见对侧 MMA 跨中线供应的 CSDH 棉絮状染色显影。故术前需综合考虑对侧 MMA 解剖情况。本文病例随访未见复发,一方面原因是 9 例(40.9%)为双侧栓塞,再通及跨中心供血概率低;另一方面可能存在样本量小、随访时间短等问题。

综上所述,硬通道穿刺引流术联合 MMA 栓塞是治疗高危复发因素的 CSDH 有效方案之一;对于手术方案适应证的把握、干预时机、术后复发等情况,仍有待多中心前瞻性随机对照临床试验进一步证实其安全性及有效性。

【伦理学声明】:本研究遵循《赫尔辛基宣言》,所有病人和/或家属均签署知情同意书。本研究方案于 2024 年 9 月 18 日经苏州市吴中人民医院伦理委员会审批,批号为:2024lw02。

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