·论著 临床诊治·

慢性硬膜下血肿经神经内镜或钻孔引流治疗效果及安全性对比分析

陈 晟 程 浩 徐昌林 黄晓娇 高 浈 李 毅
三峡大学第三临床学院 国药葛洲坝中心医院,湖北 宜昌 443002
通信作者:程浩

【摘要】 **目的** 探讨慢性硬膜下血肿(CSDH)经神经内镜或钻孔引流治疗效果及安全性。**方法** 回顾性分析三峡大学第三临床学院2019-08—2021-08收治的63例CSDH患者的临床治疗资料,根据资料中治疗方法不同进行分组,其中观察组(28例)进行神经内镜治疗,对照组(35例)进行钻孔引流治疗。采用酶联免疫吸附法检测血清神经生长因子(NGF)、神经元特异性烯醇化酶(NSE)、S100B蛋白水平。比较2组患者的手术期间相关指标、临床疗效、血清神经功能相关指标、术后并发症以及复发情况。**结果** 对照组的手术时间[(33.68±5.43)min]短于观察组[(37.56±5.52)min],住院时间[(10.16±1.23) d]长于观察组[(7.05±1.01) d],并且术后第1天、4天、7天、1个月的血肿清除率[(93.47±3.64)%,(92.19±3.62)%,(68.81±3.21)%,(65.76±3.15)%]低于观察组[(97.82±3.67)%,(95.16±3.65)%,(95.86±3.63)%,(95.58±6.64)%],$P<0.05$。对照组和观察组的总有效率分别为88.57%、96.42%,差异无统计学意义($P>0.05$)。治疗后,2组患者血清NGF、NSE、S100B蛋白水平均降低,且观察组低于对照组($P<0.05$)。观察组并发症发生率与复发率(10.71%,3.57%)明显低于对照组(31.43%,22.86%),$P<0.05$。**结论** 经神经内镜与钻孔引流两种手术方法均能够有效治疗CSDH。与钻孔引流术相比,神经内镜血肿清除术的血肿清除率更高,并且能更好的促进神经功能恢复,降低术后并发症以及血肿复发率。

【关键词】 慢性硬膜下血肿;神经内镜;钻孔引流术;血清;神经元特异性烯醇化酶;神经生长因子
【中图分类号】 R651.1+5 【文献标识码】 A 【文章编号】 1673-5110(2022)10-1221-05

Comparative analysis of efficacy and safety of chronic subdural hematoma treated by neuroendoscopy or burr hole drainage

CHEN Sheng, CHENG Hao, XU Changlin, HUANG Xiaojiao, GAO Yun, LI Yi
The Third Clinical Medical College of the Three Gorges University, Gezhouba Central Hospital of Sinopharm, Yichang 443002, China
Corresponding author:CHENG Hao

【**Abstract**】 **Objective** To investigate the efficacy and safety of neuroendoscopy or burr hole drainage for chronic subdural hematoma (CSDH). **Methods** The clinical treatment data of 63 patients with CSDH admitted to our hospital from August 2019 to August 2021 were retrospectively analyzed, and they were divided into groups according to different treatment methods in the data. Among them, the observation group (28 cases) received neuroendoscopy, and the control group (35 cases) underwent drilling and drainage treatment. Serum nerve growth factor (NGF), neuron-specific enolase (NSE) and S100B protein levels were detected by enzyme-linked immunosorbent assay. The relative indicators during operation, clinical efficacy, serum neurological function-related indicators, postoperative complications and recurrence were compared in two groups. **Results** The operation time of the control group [(33.68±5.43) min] was shorter than that of the observation group [(37.56±5.52) min], the hospi-

DOI:10.12083/SYSJ.220841
本文引用信息:陈晟,程浩,徐昌林,黄晓娇,高浈,李毅. 慢性硬膜下血肿经神经内镜或钻孔引流治疗效果及安全性对比分析[J]. 中国实用神经疾病杂志,2022,25(10):1221-1225. DOI:10.12083/SYSJ.220841
Reference information: CHEN Sheng, CHENG Hao, XU Changlin, HUANGXiaojiao, GAO Yun, LI Yi. Comparative analysis of efficacy and safety of chronic subdural hematoma treated by neuroendoscopy or burr hole drainage[J]. Chinese Journal of Practical Nervous Diseases,2022,25(10):1221-1225. DOI:10.12083/SYSJ.220841

tal stay [(10.16±1.23) days] was longer than that of the observation group [(7.05±1.01) days], and the hematoma clearance rate on the 1st day, 4th day, 7th day and 1 month after operation [(93.47±3.64)%, (92.19±3.62)%, (68.81±3.21)%, (65.76±3.15)%] were lower than those in the observation group [(97.82±3.67)%, (95.16±3.65)%, (95.86±3.63)%, (95.58±6.64)%], P<0.05. The total effective rates of the control group and the observation group were 88.57% and 96.42%, respectively, with no significant difference(P>0.05). After treatment, the serum NGF, NSE and S100B protein levels in the two groups were decreased, and the serum NGF, NSE and S100B protein levels in observation group were lower compared with control group(P<0.05). The incidence of complications and recurrence in the observation group (10.71%, 3.57%) were significantly lower compared with control group (31.43%, 22.86%), P<0.05. **Conclusion** Both neuroendoscopy and burr hole drainage can effectively treat CSDH. Compared with burr hole drainage, neuroendoscopic hematoma removal has a higher hematoma clearance rate, which can better promote the recovery of nerve function, and reduce postoperative complications and hematoma recurrence rate. It is worthy of clinical promotion.

【Key words】 Chronic subdural hematoma; Neuroendoscopy; Burr hole drainage; Serum; Neuron-specific enolase; Nerve growth factor

慢性硬膜下血肿(chronic subdural haematoma, CSDH)是指在外伤超过3周,蛛网膜和硬脑膜下腔之间出现血肿,血肿增大后出现占位效应,压迫脑干和脑室,临床表现为头痛、呕吐、意识障碍、颅内压升高等[1-2]。目前临床上主要通过药物和手术来治疗CSDH,其中手术治疗包括钻孔引流术、锥颅引流术、神经内镜血肿清除术等[3-5]。钻孔引流术是临床上治疗CSDH常用的手段,具有操作简单、创伤小等优点,但是操作过程无法在直视下进行,导致部分血肿清除不彻底,术后并发症发生率和复发率较高[6-7]。神经内镜血肿清除术能够有效清除残留血肿,术后并发症少,安全系数高,并且能够在直视下进行操作,在临床上已经取得显著成效[8-9]。但是,目前对于两种治疗方法的疗效以及安全性的相关研究尚少。因此,本研究主要探讨CSDH经神经内镜或钻孔引流治疗的疗效及安全性。

1 资料与方法

1.1 一般资料 回顾性分析三峡大学第三临床学院2019-08—2021-08收治的63例CSDH患者的临床治疗资料,根据治疗方法不同进行分组,观察组患者进行神经内镜治疗(28例),对照组患者进行钻孔引流治疗(35例)。2组患者一般资料比较差异无统计学意义(P>0.05),见表1。本研究已获三峡大学第三临床学院医学伦理委员会批准。纳入标准:(1)有明确的颅脑外伤史,且病程超过3周;(2)经影像学确诊为CSDH;(3)可容纳神经内镜操作;(4)临床资料完整。排除标准:(1)合并其他脑部疾病者,包括脑卒中、脑出血、脑梗死等;(2)肝肾功能不全者;(3)合并其他器质性疾病者;(4)合并凝血功能障碍者;(5)合并恶性肿瘤者;(6)术前接受过阿伐他汀类药物治疗。

表1 2组患者一般资料比较

Table 1 Comparison of general data of the two groups of patients

因素	对照组(n=35)	观察组(n=28)	χ^2/t值	P值
性别[n(%)]				
男	19(54.29)	15(53.57)	0.003	0.955
女	16(45.71)	13(46.43)		
年龄/(岁,$\bar{x}\pm s$)	60.73±4.14	60.25±4.13	0.458	0.649
病程/(月,$\bar{x}\pm s$)	3.51±0.73	3.53±0.74	0.107	0.915
致伤原因				
交通伤	17(48.57)	13(46.43)	0.232	0.890
摔伤	11(31.43)	8(28.57)		
其他	7(20.00)	7(25.00)		
血肿类型[n(%)]				
单侧血肿	21(60.00)	18(64.29)	0.121	0.728
双侧血肿	14(40.00)	10(35.71)		
血肿量/(mL,$\bar{x}\pm s$)	91.69±7.53	91.17±7.51	0.273	0.786

1.2 方法

1.2.1 神经内镜血肿清除术:嘱患者取侧卧位,行气管插管后进行全麻,对手术部位进行常规消毒。根据影像学资料确定血肿最密集处的位置,在此处做一个4~5 cm的切口,利用电钻钻孔,用铣刀形成3 cm大小的骨瓣,“十”字切开硬脑膜及周围血管包膜,电凝止血。首先采用吸引器吸除骨窗下的血肿,然后将神经内镜置入血肿腔内,在显示屏直视下边吸引边冲洗,清除硬膜下血肿和血肿腔内的絮状物质,连接三通,采用0.9%NaCl溶液进行重复多次的冲洗,直到冲洗液澄清为止。术后常规留置引流管,还纳骨瓣,明胶封闭钻孔,缝合切口。

1.2.2 钻孔引流术:嘱患者取侧卧位,行局部麻醉,手术部位常规消毒。根据CT显示的血肿位置,在

血肿最厚处做一个3 cm的切口，用电钻钻一个1 cm的孔，“十”字切开硬脑膜及周围血管包膜，电凝止血，见血性液体涌出后，置入无菌硅胶软管，采用0.9% NaCl溶液进行重复多次的灌洗，直到引流液清澈为止。术后留置引流管，缝合伤口。

1.3 观察指标

1.3.1 手术期间相关指标：比较2组患者的手术时间、术中出血量、住院时间、术后1 d、4 d、7 d、1个月血肿清除率。

1.3.2 临床疗效标准：①无效，术后临床症状无改善或者加重，头颅CT结果显示血肿清除率小于75%；②有效，术后临床症状有改善，头颅CT结果显示血肿清除率超过75%；③显效，术后临床症状基本消失，头颅CT结果显示血肿清除率超过90%；④治愈，术后临床症状完全消失，头颅CT结果显示血肿全部清除。总有效率=(有效+显效+治愈)例数/总例数×100%。

1.3.3 血清神经功能指标：分别在治疗前后采集患者的清晨空腹静脉血5 mL，静置30 min，3 000 r/min离心10 min，取上清液，放置于－60 ℃冰箱保存待检。采用酶联免疫吸附法检测血清神经生长因子(NGF)、神经元特异性烯醇化酶(NSE)、S100B蛋白水平。试剂盒由武汉赛培生物科技有限公司提供，具体操作根据使用说明书进行。

1.3.4 术后并发症及复发情况：比较2组患者在术后3个月内出现颅内感染、颅内积气、脑脊液漏出等并发症以及术后复发情况。

1.4 统计学方法 采用SPSS 23.0软件进行数据分析，比较用计量资料以均数±标准差($\bar{x}\pm s$)描述，采用t检验；计数资料以率(%)表示，采用四格表χ^2检验，双侧检验水平为0.05。

2 结果

2.1 2组手术期间相关指标比较 2组术中出血量比较无明显差异($P>0.05$)；对照组的手术时间短于观察组，住院时间长于观察组，并且术后1 d、4 d、7 d、1个月的血肿清除率低于观察组($P<0.05$)。见表2。

2.2 对照组和观察组患者临床疗效比较 对照组和观察组的总有效率分别为88.57%、96.42%，差异有统计学意义($P>0.05$)，见表3。

2.3 2组患者血清NGF、NSE、S100B蛋白水平比较 治疗前，2组血清NGF、NSE、S100B无明显差异($P>0.05$)；治疗后，2组患者血清NGF、NSE、S100B蛋白水平均降低，且观察组低于对照组($P<0.05$)。见表4。

表2 2组手术期间相关指标比较 ($\bar{x}\pm s$)

Table 2 Comparison of related indicators during operation between the two groups ($\bar{x}\pm s$)

观察指标	对照组(n=35)	观察组(n=28)	t值	P值
手术时间/min	33.68±5.43	37.56±5.52	2.798	0.007
术中出血量/mL	26.85±3.56	25.67±3.51	1.351	0.193
住院时间/d	10.16±1.23	7.05±1.01	10.779	<0.001
血肿清除率/%				
术后第1天	93.47±3.64	97.82±3.67	4.696	<0.001
术后第4天	92.19±3.62	95.16±3.65	3.259	0.002
术后第7天	68.81±3.21	95.86±3.63	30.198	<0.001
术后1个月	65.76±3.15	95.58±6.64	23.501	<0.001

表3 2组临床疗效比较 [例(%)]

Table 3 Comparison of clinical efficacy between the two groups [n(%)]

组别	n	无效	有效	显效	治愈	总有效
对照组	35	4(11.43)	6(17.14)	14(40.00)	11(31.43)	31(88.57)
观察组	28	1(3.57)	2(7.14)	8(28.57)	17(60.71)	27(96.42)
χ^2值						1.314
P值						0.252

表4 2组患者血清NGF、NSE、S100B蛋白水平比较 (μg/L，$\bar{x}\pm s$)

Table 4 Comparison of serum NGF, NSE and S100B protein levels between the two groups (μg/L, $\bar{x}\pm s$)

观察指标	时间	对照组(n=35)	观察组(n=28)	t值	P值
NGF	治疗前	107.86±7.84	108.94±7.85	0.543	0.590
	治疗后	74.28±6.13#	62.91±5.46#	7.538	<0.001
NSE	治疗前	17.57±2.14	17.24±2.13	0.609	0.545
	治疗后	7.66±1.37#	4.81±1.23#	8.600	<0.001
S100B蛋白	治疗前	0.63±0.13	0.61±0.12	0.628	0.533
	治疗后	0.26±0.07#	0.12±0.03#	9.870	<0.001

注：与治疗前相比，#$P<0.05$

2.4 2组术后并发症及复发情况比较 观察组并发症发生率与复发率(10.71%、3.57%)明显低于对照组(31.43%，22.86%)，差异有统计学意义($P<0.05$)，见表5。

表5 2组术后并发症以及复发情况比较 [例(%)]

Table 5 Comparison of postoperative complications and recurrence between the two groups [n(%)]

组别	n	并发症				复发
		颅内感染	颅内积气	脑脊液漏出	总计	
对照组	35	3(8.57)	5(14.29)	3(8.57)	11(31.43)	22.86(8/35)
观察组	28	1(3.57)	1(3.57)	1(3.57)	3(10.71)	3.57(1/28)
χ^2值					3.862	4.725
P值					0.049	0.030

2.5 2组典型病例 钻孔组：患者男，49岁，因“间断头痛1个月余，加重伴左侧肢体乏力3 d”入院，术前诊断右侧额颞枕顶慢性硬膜下血肿、大脑镰下疝。术前CT示右侧额颞枕顶可见最厚2.1 cm慢性硬膜下血肿，大脑镰下疝形成（图1A）；入院后行右侧硬膜下血肿钻孔引流术，术中冲洗直至冲洗液清亮；术后第1天复查头颅CT示右侧额颞顶硬膜下血肿较前明显减少，中线居中，残余厚约6 mm亚急性血肿（图1B）。

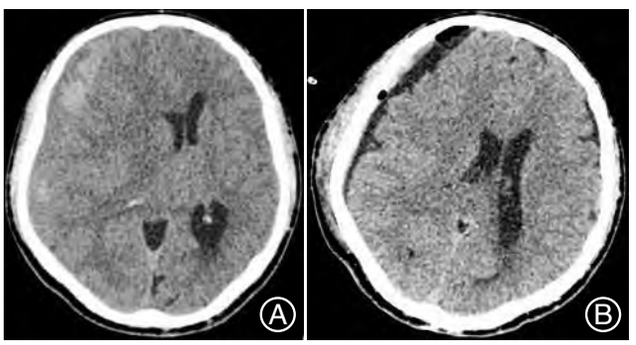

图1 钻孔引流组手术前后比较（A术前，B术后）

Figure 1 Comparison before and after operation in drilling and drainage group (A before operation, B after operation)

内镜组：患者男，52岁，因“突发头痛1周”入院，术前诊断左侧额颞顶慢性及亚急性硬膜下血肿、大脑镰下疝；术前CT示左侧额颞顶可见多处慢性及亚急性硬膜下血肿，大脑镰下疝形成（图2A）；入院后行神经内镜下左侧额颞顶硬膜下血肿清除术，术中清除血肿，并直视下清除硬膜下存在的分隔腔、增生血管等，反复冲洗至冲洗液清亮；术后第1天复查头颅CT示左侧额颞顶硬膜下血肿消失，中线居中，效果满意（图2B）。

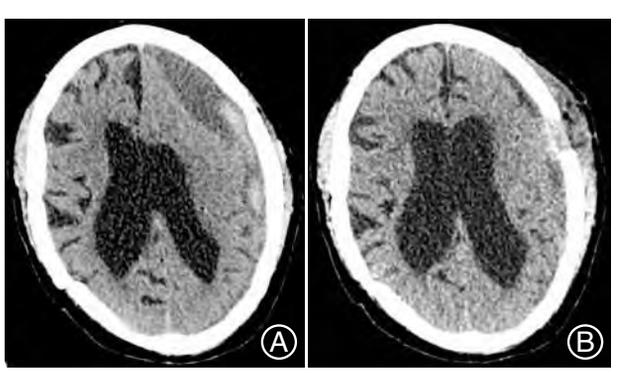

图2 神经内镜组术前术后比较（A术前，B术后）

Figure 2 Figure 2 Comparison of neuroendoscopy group before and after operation (A before operation, B after operation)

3 讨论

CSDH是神经外科常见的疾病之一，好发于中老年人，其发病机制尚不明确，可能与炎症反应、血肿外膜新生血管的形成、凝血机制障碍等因素有关[10-12]。CSDH早期临床症状比较轻微，部分患者会出现头痛、偏瘫等症状，随着血肿体积的增大，患者的病情加剧，如果治疗不及时，会引起脑组织持续性的缺血和缺氧，导致脑卒中、急性硬膜外血肿、脑疝等并发症发生，严重患者会死亡[13-14]。近年来，随着人口老龄化的加速、抗血小板和抗凝药物使用普及，CSDH的发病率逐年上升，威胁人们的生命安全[15-16]。因此早期及时进行治疗，对改善疾病预后十分重要。

本研究探讨CSDH经神经内镜或钻孔引流治疗的疗效及安全性。结果显示，对照组手术时间短于观察组，住院时间长于观察组，且术后1 d、4 d、7 d、1个月血肿清除率低于观察组（$P<0.05$）。表明神经内镜血肿清除术能够缩短住院时间，且术后血肿清除率高。研究发现，与传统引流术相比，神经内镜血肿清除术的血肿清除效果更好，与本研究一致[17-18]。钻孔引流术是临床治疗CSDH最常用的手段，具有操作简单、手术时间短等优点，但是不能够直面观察血肿腔内的情况，且引流管位置不精确，容易造成血肿清除不彻底，引起术后复发、感染[19-20]。近年来，随着内镜技术的发展，运用神经内镜治疗CSDH得到了广泛关注。神经内镜血肿清除术通过将内镜置入血肿腔内，在显示屏上可以清楚看见腔内情况，能够清除腔内各个部位的血肿，减少术后血肿残留、颅内感染、颅内积气等并发症的发生[21-23]。同时对于比较难处理的分隔型血肿，神经内镜血肿清除术可以破坏纤维隔，清除血肿[24-26]。

本文结果显示，对照组和观察组总有效率分别为88.57%、96.42%，差异无统计学意义（$P>0.05$）。表明两种方法治疗CSDH的临床疗效相当。治疗后，2组患者的血清NGF、NSE、S100B蛋白水平均降低，且观察组低于对照组（$P<0.05$）。表明两种治疗方法均能够改善患者的神经功能，但是神经内镜血肿清除术的改善效果更显著。NGF是一种神经生长调节因子，能够调节神经元的生长发育，维持神经元的存活[27]。NSE广泛存在于神经组织和神经内分泌组织内，当神经细胞受损时，NSE释放入血，能够反映神经元损害的严重程度。S100B蛋白存在于中枢神经系统的胶质细胞中，正常情况下在血清含量较低，不能通过血脑屏障，脑组织损伤后，血-脑屏障被破坏，S100B蛋白释放进入脑脊液，通过血脑屏障，其水平高低与机体颅脑损伤的严重程度有关。本文结果显示观察组并发症发生率与复发率低于对照组，表明神经内镜血肿清除术能够有效降低不良反应的发生，且术后复发率低。

两种手术方法均能够有效治疗CSDH,与钻孔引流术相比,神经内镜血肿清除术血肿清除率更高,能够更好的促进神经功能恢复,降低术后并发症以及血肿复发率,安全系数高。

4 参考文献

[1] HOFFMAN H, JALAL M S, BUNCH K M, et al. Management of chronic subdural hematoma with the subdural evacuating port system: Systematic review and meta-analysis[J]. J Clin Neurosci, 2021, 86: 154-163. DOI: 10.1016/j.jocn.2021.01.039.

[2] WANG H, WANG C, LI Z.Recurrent Bilateral Chronic Subdural Hematoma After Interventional Embolization Combined With Drilling and Drainage Treatment[J]. J Craniofac Surg, 2020, 31(2): e171-e173. DOI: 10.1097/SCS.0000000000006128.

[3] 李凯,刘志强,刘明.颅内血肿硬通道穿刺引流治疗慢性硬膜下血肿临床观察[J]. 中国实用神经疾病杂志, 2021, 24(11): 972-977. DOI: 10.12083/SYSJ.2021.10.028.

[4] ICHIMURA S, TAKAHARA K, NAKAYA M, et al. Neuroendoscopic Technique for Recurrent Chronic Subdural Hematoma with Small Craniotomy[J]. Turk Neurosurg, 2020, 30(5): 701-706. DOI: 10.5137/1019-5149.JTN.27918-19.4.

[5] FANG H, ZHANG Z, LIU Y, et al. Rigid Neuroendoscopy Assisted Hematoma Resection Reduces the Recurrence Rate of Chronic Subdural Hematoma With Mixed Density: A Retrospective Analytic Cohort Study[J]. Front Surg, 2022, 25; 9: 789118. DOI: 10.3389/fsurg.2022.789118.

[6] ZHUANG Y, JIANG M, ZHOU J, et al. Surgical Treatment of Bilateral Chronic Subdural Hematoma [J]. Comput Intell Neurosci, 2022, 2022: 2823314. DOI: 10.1155/2022/2823314.

[7] FAN Q.Pseudohypoxic Brain Swelling after Drilling and Drainage for Chronic Subdural Hematoma[J]. J Neurol Surg A Cent Eur Neurosur, 2021, 82(1): 87-89. DOI: 10.1055/s-0040-1712500.

[8] WU S, WANG H, WANG J, et al. Effect of Robot-Assisted Neuroendoscopic Hematoma Evacuation Combined Intracranial Pressure Monitoring for the Treatment of Hypertensive Intracerebral Hemorrhage [J]. Front Neurol, 2021, 12: 722924. DOI: 10.3389/fneur.2021.722924.

[9] DING H T, HAN Y, SUN D K, et al. Efficacy and safety profile of neuroendoscopic hematoma evacuation combined with intraventricular lavage in severe intraventricular hemorrhage patients[J]. Brain Behav, 2020, 10(9): e01756. DOI: 10.1002/brb3.1756.

[10] FEGHALI J, YANG W, HUANG J. Updates in Chronic Subdural Hematoma: Epidemiology, Etiology, Pathogenesis, Treatment, and Outcome [J]. World Neurosurg, 2020, 141: 339-345. DOI: 10.1016/j.wneu.2020.06.140.

[11] YOKOYA S, NISHII S, TAKEZAWA H, et al.Organized Chronic Subdural Hematoma Treated with Middle Meningeal Artery Embolization and Small Craniotomy: Two Case Reports [J]. Asian J Neurosurg, 2020, 15(2): 421-424. DOI: 10.4103/ajns.AJNS_341_19.

[12] 吴仰宗,徐云峰,林堃,等.轻型颅脑损伤后硬膜下积液演变为慢性硬膜下血肿的影响因素分析[J]. 中国实用神经疾病杂志, 2021, 24(9): 775-780. DOI: 10.12083/SYSJ.2021.11.007.

[13] AROMATARIO M, TORSELLO A, D'Errico S, et al. Traumatic Epidural and Subdural Hematoma: Epidemiology, Outcome, and Dating[J]. Medicina (Kaunas), 2021, 57(2): 125. DOI: 10.3390/medicina57020125.

[14] HART R G, PEARCE L A, GORELICK P B, et al. Aspirin Use and Risk of Subdural Hematoma: Updated Meta-Analysis of Randomized Trials[J]. J Stroke Cerebrovasc Dis, 2021, 30(8): 105911. DOI: 10.1016/j.jstrokecerebrovasdis.2021.105911.

[15] RAUHALA M, HELÉN P, HUHTALA H, et al. Chronic subdural hematoma-incidence, complications, and financial impact [J]. Acta Neurochir (Wien), 2020, 162(9): 2033-2043. DOI: 10.1007/s00701-020-04398-3.

[16] THAVARA B D, KIDANGAN G S, RAJAGOPALAWARRIER B. Comparative Study of Single Burr-Hole Craniostomy versus Twist-Drill Craniostomy in Patients with Chronic Subdural Hematoma[J]. Asian J Neurosurg, 2019, 14(2): 513-521. DOI: 10.4103/ajns.AJNS_37_19.

[17] GUO A S, LIN G S, XIE D H, et al. Effectiveness of Surgical Treatments for Basal Ganglia Hemorrhage and Imaging Factors Affecting Hematoma Evacuation Rate by Neuroendoscopic Surgery[J]. J Neurol Surg A Cent Eur Neurosurg, 2020, 81(2): 155-162. DOI: 10.1055/s-0039-1698523.

[18] ZHANG Y, SHAN A J, PENG Y P, et al. The intra-neuroendoscopic technique (INET): a modified minimally invasive technique for evacuation of brain parenchyma hematomas [J]. World J Emerg Surg, 2019, 14: 21. DOI: 10.1186/s13017-019-0239-0.

[19] YAGNIK K J, GOYAL A, VAN GOMPEL J J. Twist drill craniostomy vs burr hole drainage of chronic subdural hematoma: a systematic review and meta-analysis [J]. Acta Neurochir (Wien), 2021, 163(12): 3229-3241. DOI: 10.1007/s00701-021-05019-3.

[20] BAI J, ZHOU Y, SONG G, et al. Drilling off the Petrosal Apex and Opening the Upper Wall of Meckel's Cave Are the Key Elements of Good Outcomes in the Treatment of Trigeminal Neuralgia Secondary to Petrous Apex Meningioma[J]. J Korean Neurosurg Soc, 2022, 65 (3): 479-488. DOI: 10.3340/jkns.2021.0060.

[21] ICHIMURA S, TAKAHARA K, NAKAYA M, et al. Neuroendoscopic hematoma removal with a small craniotomy for acute subdural hematoma [J]. J Clin Neurosci, 2019, 61: 311-314. DOI: 10.1016/j.jocn.2018.11.043.

[22] KATSUKI M, KAKIZAWA Y, NISHIKAWA A, et al. Lower total protein and absence of neuronavigation are novel poor prognostic factors of endoscopic hematoma removal for intracerebral hemorrhage[J]. J Stroke Cerebrovasc Dis, 2020, 29(9): 105050. DOI: 10.1016/j.jstrokecerebrovasdis.2020.105050.

[23] UCHIDA D, NAKATOGAWA H, YAMAZOE T, et al. Neuroendoscopic Surgery with a Combination of Image Detectable Sheath, Intraoperative Computed Tomography Scan, and Navigation System Improves Accuracy and Safety in Minimally Invasive Evacuation of Intracerebral Hematoma: Technical Note [J]. World Neurosurg, 2020, 133: 1-7. DOI: 10.1016/j.wneu.2019.09.058.

[24] ZHU T, JIANG S, YANG Z, et al. A neuroendoscopic navigation system based on dual-mode augmented reality for minimally invasive surgical treatment of hypertensive intracerebral hemorrhage [J]. Comput Biol Med, 2021, 140: 105091. DOI: 10.1016/j.compbiomed.2021.105091.

[25] ATSUMI H, BABA T, SUNAGA A, et al. Neuroendoscopic Evacuation for Spontaneous Cerebellar Hemorrhage Is a Safe and Secure Approach and May Become a Mainstream Technique [J]. Neurol Med Chir (Tokyo), 2019, 59(11): 423-429. DOI: 10.2176/nmc.oa.2019-0108.

[26] MIYATA M, NONAKA M, UENO K, et al. A ventricular catheter that migrated into the fourth ventricle successfully removed using a neuroendoscope [J]. Br J Neurosurg. 2021, 26: 1-4. DOI: 10.1080/02688697.2021.1900782.

[27] MARANESI M, BOITI C, ZERANI M. Nerve Growth Factor (NGF) and Animal Reproduction[J]. Adv Exp Med Biol, 2021, 1331: 277-287. DOI: 10.1007/978-3-030-74046-7_19.