doi: 10.13241/j.cnki.pmb.2018.20.033

低浓度高渗盐水治疗重型颅脑损伤术后颅内高压的临床效果分析 *

钟旭光[1] 王国福[1] 林耀新[1] 苏绮璇[1] 杨嘉玲[1] 郭 春[2]

(1 佛山市第一人民医院神经外科 广东 佛山 528000;2 河南大学第一附属医院 河南 开封 475000)

摘要 目的:探讨低浓度的高渗盐水对重型颅脑损伤患者手术后颅内高压的治疗效果。**方法:**选取 2014 年 8 月至 2017 年 8 月本院收治的 104 例行去骨瓣减压术后出现颅内高压的重型颅脑损伤患者为研究对象,按照随机数表法将其分为实验组、观察组,每组各 52 例。在持续监测颅内压(ICP)的情况下,实验组、观察组分别给予 233.3 mL 的 3% HS、29.9 mL 的 23.4% HS,比较两组治疗前后的 ICP、平均动脉压(MAP)、中心静脉压(CVP)、血钠(Na^+)、钾(K^+)、渗透压、肌酐(Cr)、尿素氮(BUN)水平的变化及半年的预后情况。**结果:**两组治疗后 30 min 时 ICP 显著低于治疗前,而 MAP 明显高于治疗前(*P <0.05*);实验组治疗后 240 min、300 min 时 ICP 显著低于观察组,120 min、240 min、300 min、360 min 时 MAP 均显著高于观察组(*P <0.05*);两组治疗前后的 CVP 比较差异无统计学意义(*P>0.05*)。两组治疗后 3 d、6 d 血 Na+ 均显著高于治疗前,治疗后 1 d、3 d、6 d 的渗透压均显著高于治疗前(*P <0.05*),两组治疗前后的血 K^+、Cr、BUN 比较差异无统计学意义(*P >0.05*);两组治疗前后的同期各血生化指标比较差异无统计学意义(*P>0.05*)。实验组治疗半年后死亡 6 例(11.5%),预后不良 14 例(26.9%),预后良好 32 例(61.5%),观察组死亡 8 例(15.4%),预后不良 20 例(38.5%),预后良好 24 例(46.2%),两组比较差异无统计学意义(*P>0.05*)。**结论:**3%和 23.4%两种浓度的 HS 均能安全迅速降低重型颅脑损伤患者的 ICP,且均有明显的扩容效果,但低浓度 HS 作用持续时间更长。

关键词:颅脑损伤;危重病;颅内高压;盐水;高渗

中图分类号:R651.1 **文献标识码:**A **文章编号:**1673-6273(2018)20-3945-04

Analysis of the Effect of Low Concentration and Hypertonic Saline on the Intracranial Hypertension after Severe Craniocerebral Injury

ZHONG Xu-guang[1], WANG Guo-fu[1], LIN Yao-xin[1], SU Qi-xuan[1], YANG Jia-ling[1], GUO Chun[2]

(1 Department of Neurosurgery, the first people's Hospital of Foshan City, Foshan, Guangdong, 528000, China;

2 First Affiliated Hospital of Henan University, Kaifeng, Henan 475000, China)

ABSTRACT Objective: To study the clinical effect of low concentration of hypertonic saline on the postoperative intracranial hypertension in patients with severe craniocerebral injury. **Methods:** 104 cases of patients with severe craniocerebral injury who experienced intracranial hypertension after craniectomy and admitted in our hospital from August 2014 to August 2017 were selected and randomly divided into the experimental group and the observation group with 52 cases in each group. Under the condition of continuous monitoring of intracranial pressure (ICP), both groups were treated with 233.3 mL of 3% HS and 29.9 mL 23.4% HS respectively . The changes of ICP, mean arterial pressure (CVP), serum sodium (Na^+), potassium (K^+), osmotic pressure, creatinine (Cr) , urea nitrogen (BUN) levels were compared before and after treatment between two groups and the prognosis of patients with half a year was recorded. **Results:** The ICP was lower than that before treatment and the MAP was higher than that before treatment at 30 min after treatment in both groups (*P<0.05*). There was no significant difference in the ICP, MAP and CVP between the two groups before treatment (*P>0.05*). The ICP in the experimental group was significantly lower than that in the observation group at 240 min and 300 min, and the MAP in the experimental group was significantly higher than that in the observation group at 120 min, 240 min, 300 min and 360 min (*P<0.05*). There was no significant difference in the CVP between the two groups before and after treatment (*P>0.05*). The serum Na^+ in both groups were significantly higher than that before treatment and at 3 and 6 days after treatment. And the osmotic pressure was significantly higher than that before treatment at 1d, 3d and 6d after treatment (*P<0.05*). There was no significant difference in the blood K^+, Cr, BUN between the two groups (*P>0.05*). And there was no significant difference in the blood biochemical indexes between the two groups before and after treatment (*P>0.05*). Six months later, six patients (11.5%) died of disease, 14 cases (26.9%) had poor prognosis, 32 cases (61.5%) had good prognosis in the experimental group, and 8 cases (15.4%) died of disease, 20 cases (38.5%) had poor prognosis and 24 cases (46.2%) had good prognosis in the observation group, there was no statistical difference between the two groups (*P>0.05*). **Conclusion:** Both 3% and 23.4% concentrations of HS could effectively reduce ICP rapidly in patients with severe craniocerebral injury with safety, but the duration of low concentration of HS was longer.

* 基金项目:国家自然科学基金项目(81371981)

作者简介:钟旭光(1980-),男,硕士研究生,主治医师,研究方向:癫痫及功能神经外科,涉及脑功能区的手术临床工作,

E-mail: zhqn40@126.com

(收稿日期:2018-07-08 接受日期:2018-07-28)

Key words: Craniocerebral injury; Critical disease; Intracranial hypertension; Saline; Hypertonic
Chinese Library Classification(CLC): R651.1 Document code: A
Article ID: 1673-6273(2018)20-3945-04

前言

颅内高压是重型颅脑损伤的常见并发症之一，严重者甚至可出现脑疝，威胁患者的生命。近年来，HS 应用于降低颅内压(intracranial pressure，ICP)的效果受到广泛关注，具有经典的甘露醇(MT)溶液类似的效果，且并发症较少，可改善患者全身炎性反应与血流动力学[1-4]。然而，不同 HS 浓度在降低重型颅脑损伤颅内高压的起效及持续时间不尽相同。目前，临床上常用 HS 浓度有 3%和 23.4%两种，但是具体哪种浓度的 HS 临床效果最佳目前尚无定论。本研究选取 2014 年 8 月至 2017 年 8 月本院收治的 104 例行去骨瓣减压术后出现颅内高压的重型颅脑损伤患者为研究对象，将其随机分为两组，分别给予 3%HS 和 23.4%HS，通过观察和比较其 ICP、血流动力学与血生化指标等的变化，并随访其半年的预后情况，旨在明确不同浓度低浓度高渗盐水治疗重型颅脑损伤术后颅内高压的临床效果。现将结果报道如下。

1 资料与方法

1.1 一般资料

选取 2014 年 8 月至 2017 年 8 月本院收治的 104 例行去骨瓣减压术后出现颅内高压的重型颅脑损伤患者为研究对象，包括男 78 例，女 26 例，年龄 18~71(32.9 ± 7.8)岁。所有患者按照随机数表法分为实验组、观察组，每组各 52 例。入选标准：① 颅脑受伤史明确，入院时格拉斯哥昏迷评分(GCS)<9 分；② 根据术前 ICP 和(或)头颅 CT 检查决定在气管插管全麻下行标准的去骨瓣减压术，术后 ICP>15 mmHg 并持续至少 0.5 h；③ 入院时的血钠(Na^+)、钾(K^+)、渗透压、血肌酐(Cr)、血尿素氮(BUN)等生化指标均正常；④ 年龄≥ 18 岁。排除标准：① 合并心、肝、肾等其他脏器的创伤或严重疾病；② 合并脑肿瘤等其他中枢神经系统疾病；③ 临床及随访资料不完整者。本研究经患者家属知情同意并签署知情同意书，经本院伦理委员会批准通过。

1.2 方法

全部患者均常规给予抗炎、镇痛、镇静、改善微循环、降糖、脑保护等治疗，将体温控制在 <37℃，持续有创监测 ICP，当出现颅内高压(术后 ICP>15 mmHg 并持续至少 0.5 h)时给予降颅内高压治疗，实验组、观察组两组分别给予 233.3 mL 的 3% HS、29.9 mL 的 23.4%HS，均在 30 min 左右滴注完毕。当再次出现颅内高压时再次给予上述剂量的药液，24 h 内的最大剂量≤ 4 次或血 Na^+≤ 160 mmol / L。若给予脱水治疗后 ICP 进行性升高或降低后迅速升高者则复查头颅 CT，若 >40 mmHg 且难以降低时可考虑再次急诊手术，术后继续脱水治疗。

1.3 观察指标

采用德国 Spiegeiberg 公司提供的 ICP 持续监测仪和传导器持续监测 ICP 的变化，记录三组治疗前、治疗后 30 min、60 min、120 min、240min、300 min、360 min 患者 ICP、平均动脉压(MAP)、中心静脉压(CVP)等，以及治疗前、治疗后 120 min、300 min、1 d、3 d、6 d 的血 Na^+、K^+、渗透压、Cr、BUN 等值的变化，随访患者半年，记录格拉斯哥预后(GOS)评分。GOS 评分的总分为 1~5 分，1 分为死亡，2~3 分提示预后不良，≥ 4 分则为预后良好。

1.4 统计学处理

所有数据均采用 SPSS 18.0 统计学软件进行处理，计量资料采用($\bar{x} \pm s$)表示，组间比较采用 t 检验，计数资料组间比较采用 χ^2 检验，以 $P<0.05$ 视为差异具有统计学意义。

2 结果

2.1 两组治疗前后 ICP、MAP 和 CVP 比较

两组治疗后 30 min 时 ICP 低于治疗前，MAP 高于治疗前，差异有统计学意义($P<0.05$)；两组治疗前 ICP、MAP、CVP 比较，差异无统计学意义 ($P>0.05$)，实验组治疗后 240 min、300 min 时 ICP 显著低于观察组，120 min、240 min、300 min、360 min 时 MAP 均显著高于观察组，差异有统计学意义($P<0.05$)。两组治疗前后的 CVP 比较差异无统计学意义($P>0.05$)，见表 1。

2.2 两组治疗前后相关血生化指标比较

两组治疗后 3 d、6 d 血 Na^+ 均显著高于治疗前，治疗后 1d、3 d、6 d 的渗透压均显著高于治疗前，差异有统计学意义 ($P<0.05$)，两组治疗前后的血 K^+、Cr、BUN 比较，差异无统计学意义($P>0.05$)。两组治疗前后的同期各血生化指标比较差异无统计学意义($P>0.05$)，见表 2。

2.3 两组治疗半年后预后情况比较

两组治疗半年后，实验组死亡 6 例(11.5%)，预后不良 14 例(26.9%)，预后良好 32 例(61.5%)，观察组实验组死亡 8 例(15.4%)，预后不良 20 例(38.5%)，预后良好 24 例(46.2%)，两组比较差异无统计学意义(P=0.298)。

3 讨论

颅内高压的临床治疗通常情况下包括手术和药物两种方法，手术治疗主要指去骨瓣减压术，其能迅速降低 ICP，但术后容易因水肿、出血等导致再次出现颅内高压，此时应及时通过 HS 或 MT 等药物降低 ICP，否则不利于患者的脑功能的恢复。MT 是经典的降低颅内高压的脱水药物[5]，能通过提高血渗透压来达到控制脑内容积和脑水肿的目的，但其具有一定的肾毒性和利尿效果，若长期重复用药可引起肾衰、血电解质紊乱等严重并发症，限制了其应用，故临床上急需要一种新的安全可靠的降 ICP 药物。相关研究显示高渗盐水治疗重型颅脑创伤临床效果显著，能够增加患者 MAP、CPP 以及 GCS 评分，同时还能降低患者 APACHEⅡ评分[6]。Pasarikovski CR 等研究[7]表明 HS 与甘露醇一样有效降低 ASHA 中的 ICP。作为脱水药物，HS 最早应用于动物实验，上世纪八十年代其开始用于临床上治疗 MT 无效的颅内高压患者，近年来 HS 广泛于临床。相关研究显示[8]其可降低患者 ICP，缓解脑水肿，且安全性较高，应用效果令人满意，尤其是对于 MT 抵抗的颅内高压患者和高颅压危象者。

HS 的作用机制除了与在细胞内外形成持续渗透梯度有关

表 1 两组治疗前后 ICP、MAP 和 CVP 比较(mmHg，n=52)

Table 1 Comparison of the ICP, MAP and CVP before and after treatment between two groups(mmHg，n=52)

Groups	Time point	ICP	MAP	CVP
Experimental group	Pretherapy	25.35± 3.65	80.05± 7.73	9.32± 2.50
	At 30min post-treatment	15.50± 3.01	83.90± 5.54	10.19± 2.37
	At 60min post-treatment	14.87± 3.24	90.10± 6.96	10.46± 2.59
	At 120min post-treatment	15.31± 3.10	95.53± 6.02	10.52± 2.42
	At 240min post-treatment	16.59± 3.22	92.89± 4.70	10.00± 2.95
	At 300min post-treatment	19.54± 3.69	88.00± 5.10	10.29± 2.52
	At 360min post-treatment	23.10± 4.21	83.86± 3.88	9.65± 1.98
Observation group	Pretherapy	26.27± 3.86	79.10± 6.97	9.41± 2.31
	At 30min post-treatment	15.32± 3.26	87.01± 7.10	10.32± 2.54
	At 60min post-treatment	15.00± 3.10	86.54± 6.57	10.20± 2.28
	At 120min post-treatment	15.96± 2.97	85.97± 7.29	10.08± 1.98
	At 240min post-treatment	18.67± 3.66	83.38± 6.19	9.86± 2.49
	At 300min post-treatment	23.00± 4.01	80.50± 6.62	9.52± 2.38
	At 360min post-treatment	25.48± 4.57	78.81± 7.22	9.32± 2.27

表 2 两组治疗前后的血生化指标比较(n =52)

Table 2 Comparison of the blood biochemical indexes between the two groups before and after treatment(n =52)

Groups	Time point	Na^+	K^+	Osmotic pressure	Cr	BUN
Experimental group	pretherapy	138..21± 7.32	3.92± 0.90	301.69± 8.22	81.90± 11.12	5.97± 1.44
	At 120min post-treatment	140.02± 8.14	3.87± 1.05	303.79± 8.84	83.35± 12.55	6.38± 1.49
	At 300min post-treatment	141.75± 9.28	3.90± 1.15	306.36± 9.12	88.10± 13.66	6.80± 1.62
	At 1d post-treatment	143.07± 10.22	3.79± 0.87	310.00± 9.01	86.19± 12.21	6.61± 1.32
	At 3d post-treatment	148.21± 8.88	4.04± 0.51	319.22± 10.10	85.18± 11.65	6.22± 1.70
	At 6d post-treatment	147.38± 7.19	3.81± 0.90	321.92± 9.93	84.07± 10.22	5.88± 1.48
Observation group	pretherapy	139.01± 6.89	4.02± 0.65	303.28± 7.88	82.77± 12.39	6.22± 1.54
	At 120min post-treatment	141.18± 8.86	3.94± 0.81	305.73± 8.21	84.47± 13.05	6.87± 1.73
	At 300min post-treatment	142.02± 10.02	3.97± 0.95	308.10± 10.01	88.78± 13.83	7.11± 1.87
	At 1d post-treatment	143.59± 9.62	3.86± 0.71	313.1± 10.21	88.02± 11.95	7.06± 1.76
	At 3d post-treatment	147.75± 9.54	3.95± 0.84	323.01± 11.59	84.73± 12.89	6.78± 1.59
	At 6d post-treatment	149.19± 10.18	3.88± 1.00	327.05± 10.96	85.10± 9.97	6.38± 1.54

外，其还能调节机体的免疫功能，抑制炎性反应，减轻缺血再灌注所致的脑水肿，且能提高 MAP，减轻血流阻力，改善脑灌注[9]。Alnemari AM 等研究[10]表明使用高渗盐水是立即降低颅内压的最佳选择，并持续改善重型颅脑损伤的死亡率。本研究结果显示两组治疗后 30 min 时 ICP 低于治疗前，MAP 高于治疗前，实验组治疗后 240 min、300 min 时 ICP 显著低于观察组，120 min、240 min、300 min、360 min 时 MAP 均显著高于观察组。两组治疗后 3 d、6 d 血 Na^+ 均显著高于治疗前，治疗后 1 d、3 d、6 d 的渗透压均显著高于治疗前，表明作为脱水药物 HS 可以降低重型颅脑损伤患者颅内压，与 Burgess S 报道一致。申晓伟等 [11] meta 分析结果显示 HS 在降低 ICP 和减轻脑水肿方面比 MT 更加安全有效，持续时间更长，并发症更少。

常用的 HS 浓度包括 3%、10%和 23.4%数种，3% HS 的渗透压与 20%MT 的渗透压接近，而其降低 ICP 的持续时间更长，在维持血流动力学稳定和改善内环境方面更佳[12]。孙诚等[13]研究表明 10%和 23.4%HS 均能有效降低 ICP，其效果与单次静脉推注的 NaCl 总量有关。刘万宝等[14]研究表明与 MT 比较，HS 抢救颅脑损伤导致急性颅内高压的效果更加，维持 ICP 更加稳定，且 3%和 10%的 HS 均能显著提高 MAP 和脑灌注压，具有明显的扩容效果，3%HS 的持续时间更长。秦德广等研究表明与 20%MT 相比，3%HS 起效更快，维持时间更长，且对肾功能无明显影响，安全可靠[15]。虽然各种常用 HS 浓度的都能降低患者颅内压，但是但低浓度 HS 持续时间更长[16-18]，其原因可能与对患者首次使用后，其机体内的血液对 3%HS 稀释速慢，而对 10%HS 的稀释速度快[19-21]，同时机体内使用 10%HS 后 Na^+ 的转移清除比 3%HS 快[22-24]，机体内血 Na+ 浓度降低快，故低浓

度 HS 持续时间更长[25]。

本研究重点比较了 3%和 23.4%两种浓度 HS，均在 30 min 左右滴注完毕，结果表明两组用药后均在 30 min 左右起效，迅速降低 ICP 的同时显著升高 MAP，3%HS 的持续时间更长，治疗后 6 h 的 ICP 仍显著高于治疗前，而 23.4%HS 的降低 ICP 作用持续到 5 h 左右，升高 MAP 的作用持续到 240 min，且实验组治疗后 240 min、300 min 的 ICP 显著低于观察组，120 min、240 min、300 min、360 min 的 MAP 均显著高于观察组，提示 3%HS 的改善脑水肿和扩容效果更好。此外，本研究表明两组治疗后 3 d 开始血 Na^+ 明显升高，治疗后 1 d 开始的渗透压显著升高，两组血清 Cr、BUN 水平均未显著升高，且两组治疗前后的同期各血生化指标比较无显著差异，提示 3%和 23.4%两种浓度的 HS 对患者的血电解质和肾功能影响相似，安全性均较高。

综上所述，本研究结果表明 3%和 23.4%两种浓度的 HS 均能安全迅速降低重型颅脑损伤患者的 ICP，且均有明显的扩容效果，但低浓度 HS 作用持续时间更长。

参 考 文 献(References)

[1] Pascual JL，Maloney-Wilensky E，Reilly PM,et al.Resuscitation of hypotensive head-injured patients:is hypertonic saline the answer[J]? Am Surg, 2008, 74(3): 253-259

[2] Kamel H, Navi BB, Nakagawa K, et al. Hypertonic saline versus mannitol for the treatment of elevated intracranial pressure: a meta-analysis of randomized clinical trials [J]. Crit Care Med, 2011, 39(3): 554-559

[3] Mangat HS. Hypertonic saline infusion for treating intracranial hypertension after severe traumatic brain injury [J]. Crit Care, 2018, 22(1): 37

[4] Li M, Chen T, Chen SD, et al. Comparison of equimolar doses of mannitol and hypertonic saline for the treatment of elevated intracranial pressure after traumatic brain injury: a systematic review and meta-analysis[J]. Medicine (Baltimore), 2015, 94(17): e736

[5] 周丹，刘茹，刘俊.持续性颅内压监护对高血压脑出血治疗手术时机及甘露醇用量调控的指导价值研究[J].中国医学创新，2018，15(5): 112-115
Zhou Dan, Liu Ru, Liu Jun. Guiding Value of Continuous Intracranial Pressure Monitoring on the Timing of Operation and Mannitol Dosage in Patients with Hypertensive Intracerebral Hemorrhage [J]. Medical Innovation of China, 2018, 15(5): 112-115

[6] 张真，刘金龙，吴旭江.高渗盐水治疗重型颅脑创伤合并休克患者的临床应用价值[J].中国社区医师，2017，33(6):32-33
Zhang Zhen, Liu Jinlong, Wu Xujiang. Clinical value of hypertonic saline in the treatment of severe traumatic brain injury complicated with shock[J]. CHinese Community Doctors, 2017, 33(6): 32-33

[7] Pasarikovski CR, Alotaibi NM, Al-Mufti F, et al. Hypertonic Saline for Increased Intracranial Pressure After Aneurysmal Subarachnoid Hemorrhage: A Systematic Review[J]. World Neurosurg, 2017, 105: 1-6

[8] da Silva JC, de Lima Fde M, Valen.a MM, et al. Hypertonic saline more efficacious than mannitol in lethal intracranial hypertension model[J]. Neurol Res, 2010, 32(2): 139-143

[9] Strandvik GF. Hypertonic saline in critical care:a review of the literature and guidelines for use in hypotensive states and raised intracranial pressure[J]. Anaesthesia, 2009, 64(9): 990-1003

[10] Alnemari AM, Krafcik BM, Mansour TR, et al. A Comparison of Pharmacologic Therapeutic Agents Used for the Reduction of Intracranial Pressure After Traumatic Brain Injury [J]. World Neurosurg, 2017, 106: 509-528

[11] 申晓伟，王宏勤.高渗盐水和甘露醇治疗颅内高压安全性和有效性的系统评价[J].中国医药导报，2011，08(12): 11-13
Shen Xiao-wei, Wang Hong-qin. Comparison between HS with Mannitol in the Treatment of Intracranial Hypertension: A Systematic Review[J]. China Medical Herald, 2011, 08(12): 11-13

[12] 周冬青，谢海，马乃全，等.颅内高压患者术中应用 3%高渗盐水与 20%甘露醇后血流动力学的变化[J].中华实验外科杂志，2012，29(7): 1396-1398
Zhou Dong-qing, Xie Hai, Ma Nai-quan, et al. Blood circulation changes after application of 3 % hypertonic saline vs 20 % mannitol in intracranial hypertensive patients [J]. Chinese Journal of Experimental Surgery, 2012, 29(7): 1396-1398

[13] 孙诚，曾文新，陈纯波，等.不同浓度高渗盐水治疗颅内高压的疗效及安全性[J].广东医学，2012，33(2): 212-214
Sun Cheng, Ceng Wen-xin, Chen Chun-bo, et al. Study on clinical effects of hypertonic saline of different concentrations on hypertensive cerebral hemorrhage [J]. Guangdong Medical Journal, 2012, 33(2): 212-214

[14] 刘万宝，刘剑，乔着意，等.高渗盐水抢救颅脑损伤所致急性颅内高压的临床研究[J].中国急救医学，2011，31(9): 777-780
Liu Wan-bao, Liu Jian, Qiao Zhuo-yi, et al. Clinical research about the curative effect of hypertonic saline on acute intracranial hypertension caused by craniocerebral injury [J]. Chinese Journal of Critical Care Medicine, 2011, 31(9): 777-780

[15] 秦德广，黄文勇，杨灵，等.高渗盐水在重型颅脑损伤去骨瓣减压术后颅内高压治疗中的应用研究 [J]. 中华神经医学杂志，2016，15(12): 1267-1273
Qin De-guang, Huang Wen-yong, Yang Ling, et al. Hypertonic saline in treatment of intracranial hypertension caused by severe cerebral trauma after decompressive craniectomy [J]. Chinese Journal of Neuromedicine, 2016, 15(12): 1267-1273

[16] Ali A, Tetik A, Sabanci PA, et al. Comparison of 3% Hypertonic Saline and 20% Mannitol for Reducing Intracranial Pressure in Patients Undergoing Supratentorial Brain Tumor Surgery: A Randomized, Double-blind Clinical Trial[J]. J Neurosurg Anesthesiol, 201830(2): 171-178

[17] Ali A1, Şencan B, Sabancı PA, et al. A Comparison of the Effects of 20% Mannitol and 3% NaCl on Coagulation Parameters In Vitro using ROTEM: A Prospective Randomized Crossover Study[J]. Turk J Anaesthesiol Reanim, 2017, 45(2): 87-92

[18] Hernández-Palazón J, Fuentes-García D, Doménech-Asensi P, et al. A comparison of equivolume, equiosmolar solutions of hypertonic saline and mannitol for brain relaxation during elective supratentorial craniotomy[J]. Br J Neurosurg, 2016, 30(1): 70-75

（下转第 3936 页）

[J]. World Journal of Nuclear Medicine, 2016, 15(2): 81-84

[11] Riva M A, Ferretti C, Pagni F. Duran Madonna (c. 1435-1438) by Rogier van der Weyden: a case of congenital goiter [J]. Internal & Emergency Medicine, 2016, 11(8): 1-2

[12] Olson AC, Haugen BR, Walter J, et al. SPECT/CT and I131 therapy of brain metastases from follicular variant papillary thyroid carcinoma (FVPTC)[J]. J Clin Endocrinol Metab, 2014, 99(10): 3511-3512

[13] Hussein O, Karen D, Zidan J. Cisplatin based chemotherapy in patients with advanced differentiated thyroid carcinoma refractory to I131 treatment[J]. Indian J Med Paediatr Oncol, 2013, 34(4): 234-237

[14] Vos X G, Endert E, Zwinderman A H, et al. Predicting the Risk of Recurrence Before the Start of Antithyroid Drug Therapy in Patients With Graves' Hyperthyroidism [J]. J Clin Endocrinol Metab, 2016, 101(4): 1381-1389

[15] Cunha F M, Rodrigues E, Oliveira J, et al. Graves' disease in a mediastinal mass presenting after total thyroidectomy for nontoxic multinodular goiter: a case report[J]. Journal of Medical Case Reports, 2016, 10(1): 70

[16] Szatkowska M, Zimny D, Barg E. Down syndrome and hyperthyroidism - two case reports [J]. Pediatric Endocrinology Diabetes & Metabolism, 2016, 21(2): 93

[17] Cao L, Ding W, Du J, et al. Effects of curcumin on antioxidative activities and cytokine production in Jian carp (Cyprinus carpio var. Jian) with CCl 4 -induced liver damage [J]. Fish & Shellfish Immunology, 2015, 43(1): 150-157

[18] Gauthé M, Sarfati J, Bourcigaux N, et al. Pituitary Adenoma Recurrence Suspected on Central Hyperthyroidism Despite Empty Sella and Confirmed by 68Ga-DOTA-TOC PET/CT [J]. Clinical Nuclear Medicine, 2017, 42(6): 454

[19] Burhan I, Khan A K, Adam A K. Significance of TPO and Some Biochemical Parameters in Goiter Patients[J]. International Journal of Pharmaceutical Sciences Review & Research, 2016, 40(2 46): 251-254

[20] Kruljac I, Solter D, Vrkljan A M, et al. Remission of Graves' disease is not related to early restoration of euthyroidism with high-dose methimazole therapy[J]. Endocrine Research, 2015, 40(1): 1-4

[21] Amato E, Campennì A, Leotta S, et al. Treatment of hyperthyroidism with radioiodine targeted activity: A comparison between two dosimetric methods[J]. Physica medica : PM: an international journal devoted to the applications of physics to medicine and biology: official journal of the Italian Association of Biomedical Physics (AIFB), 2016, 32(6): 847

[22] Kuanrakcharoen P. Radioiodine (1-131) Dose for the Treatment of Hyperthyroidism in Rajavithi Hospital [J]. Journal of the Medical Association of Thailand, 2016, 99 Suppl 2(3): S123

[23] Darwish S M, Ghadban W K, Zirie M A, et al. Success rate of radioiodine treatment of hyperthyroidism in Qatari patients [J]. Qatar Medical Journal, 2016, 18(1): 42-46

[24] Zuhur S S, Baykiz D, Kara S P, et al. Relationship Among Pulmonary Hypertension, Autoimmunity, Thyroid Hormones and Dyspnea in Patients With Hyperthyroidism [J]. American Journal of the Medical Sciences, 2017, 353(4): 374

[25] Donangelo I, Suh S Y. Subclinical Hyperthyroidism: When to Consider Treatment[J]. American Family Physician, 2017, 95(11):710

[26] Shyamasunder A H, Abraham P. Measuring TSH receptor antibody [TRAb] to influence treatment choices in Graves' disease[J]. Clinical Endocrinology, 2017, 86(5): 652-657

[27] Köhler I, Ballhausen B D, Stockhaus C, et al. Prevalence of and risk factors for feline hyperthyroidism among a clinic population in Southern Germany [J]. Tierarztliche Praxis Ausgabe K Kleintiere/ heimtiere, 2016, 44(3): 89-92

[28] Sharma S D, Kumar G, Guner K, et al. Hyperthyroidism in patients with thyroid cancer[J]. Ear Nose Throat J, 2016, 95(6): 236-239

[29] Kadia B M, Dimala C A, Bechem N N, et al. Concurrent hyperthyroidism and papillary thyroid cancer: a fortuitous and ambiguous case report from a resource-poor setting[J]. Bmc Research Notes, 2016, 9(1): 369

[30] V. G. Likhvantseva, E. A. Rudenko, S. G. Kapkova, et al. Explore the Possibility of Early Clinical Diagnosis of Endocrine Ophthalmopathy Based on Eye Symptoms of Hyperthyroidism [J]. Ophthalmology in Russia, 2016, 13(4): 252-259

(上接第 3948 页)

[19] Prabhakar H, Singh GP, Anand V, et al. Mannitol versus hypertonic saline for brain relaxation in patients undergoing craniotomy [J]. Cochrane Database Syst Rev, 2014, 16(7): CD010026

[20] Mangat HS, Chiu YL, Gerber LM, et al. Hypertonic saline reduces cumulative and daily intracranial pressure burdens after severe traumatic brain injury[J]. J Neurosurg, 2015, 122(1): 202-210

[21] Burgess S, Abu-Laban RB, Slavik RS, et al. A Systematic Review of Randomized Controlled Trials Comparing Hypertonic Sodium Solutions and Mannitol for Traumatic Brain Injury: Implications for Emergency Department Management[J]. Ann Pharmacother, 2016, 50 (4): 291-300

[22] Sokhal N, Rath GP, Chaturvedi A, et al. Comparison of 20% mannitol and 3% hypertonic saline on intracranial pressure and systemic hemodynamics[J]. J Clin Neurosci, 2017, 42: 148-154

[23] Dostalova V, Astapenko D, Dostalova V Jr, et al. The Effect of Fluid Loading and Hypertonic Saline Solution on Cortical Cere bral Microcirculation and Glycocalyx Integrity [J]. J Neurosurg Anesthesiol, 2018 Jul 13.[Epub ahead of print]

[24] Gu J, Huang H, Huang Y, et al. Hypertonic saline or mannitol for treating elevated intracranial pressure in traumatic brain injury: a meta-analysis of randomized controlled trials [J]. Neurosurg Rev, 2018, Jun 15[Epub ahead of print]

[25] Correia CJ, Armstrong R Jr, Carvalho PO, et al. Hypertonic Saline Solution Reduces Microcirculatory Dysfunction and Inflammation in a Rat Model of Brain Death[J]. Shock, 2018, 23[Epub ahead of print]