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脑电双频谱指数监测下麻醉在老年骨科手术中的应用效果 及对血清 S100 β 水平的影响

耿莹, 周海英

(江阴市中医院消毒供应室, 江苏 江阴 214400)

[摘要] 目的: 探讨脑电双频谱指数(bispectral index, BIS)监测下麻醉应用于老年骨科手术中的效果及对血清中枢神经特异性蛋白 β (S100 β)水平的影响。方法: 选择2018年2月至2022年2月江阴市中医院收治行老年骨科手术的104例患者, 随机分为对照组与研究组, 各52例。对照组依据麻醉医师经验及患者临床症状体征调节麻醉深度, 研究组依据BIS监测数据调节麻醉深度。对比两组术中主要麻醉药物用量、术后恢复指标、各时间点血流动力学指标、血清S100 β 水平、蒙特利尔认知评估量表(Montreal Cognitive Assessment, MoCA)评分、谵妄诊断量表(the Confusion Assessment Method, CAM)评分变化及麻醉苏醒期不良反应发生率。结果: 研究组枸橼酸舒芬太尼注射液、异丙酚注射液用量均少于对照组, 术后苏醒时间、拔管时间均短于对照组(均 $P<0.05$)。研究组 T_1 、 T_2 、 T_3 、 T_4 的心率(heart rate, HR)、收缩压(systolic blood pressure, SBP)、舒张压(diastolic blood pressure, DBP)、平均动脉压(mean arterial pressure, MAP)水平均低于对照组(均 $P<0.05$)。研究组术后24、72 h血清S100 β 水平、CAM评分均低于对照组, MoCA评分高于对照组(均 $P<0.05$)。研究组麻醉苏醒期总不良反应发生率为5.77%(3/52), 低于对照组($P<0.05$)。结论: BIS监测下麻醉应用于老年骨科手术中可减少麻醉药物用量, 改善血流动力学水平及认知功能, 降低血清S100 β 水平, 促进术后恢复, 减少不良反应。

[关键词] 脑电双频谱指数监测; 老年; 骨科; 血流动力学; 血清S100 β ; 认知功能; 不良反应

Effect of bispectral index monitoring anesthesia in elderly orthopaedic surgery and its effect on serum S100 β

GENG Ying, ZHOU Haiying

(Disinfection Supply Room, Jiangyin Traditional Chinese Medicine Hospital, Jiangyin Jiangsu 214400, China)

Abstract **Objective:** To investigate the effect of anesthesia in elderly orthopedic surgery under the monitoring of bispectral index (BIS) and its effect on serum central nervous system specific protein β (S100 β) level. **Methods:** A total of 104 elderly patients who underwent orthopedic surgery in Jiangyin Hospital of Traditional Chinese Medicine from February 2018 to February 2022 were randomly divided into a control group and a study group, with 52 cases in each group. The control group adjusted the depth of anesthesia according to the experience of the anesthesiologist and the clinical symptoms and signs of the patients, while the study group adjusted the depth of anesthesia

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通信作者 (Corresponding author): 周海英, Email: 17768318586@163.com

according to the BIS monitoring data. The intraoperative dosage of main anesthetic drugs, postoperative recovery indicators, hemodynamic indicators at each time point, serum S100 β level, Montreal Cognitive Assessment (MoCA) score, the Confusion Assessment Method (CAM) score changes, and the incidence of adverse reactions during recovery from anesthesia were compared between the 2 groups. **Results:** The dosage of sufentanil citrate injection and propofol injection in the study group was less than that in the control group, and the postoperative recovery time and extubation time were shorter than those in the control group (all $P < 0.05$). The levels of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) at T_1 , T_2 , T_3 , and T_4 in the study group were lower than those in the control group (all $P < 0.05$). The serum S100 β level and CAM score of the study group at 24 and 72 h after the operation were lower than those of the control group, and the MoCA score was higher than that of the control group (all $P < 0.05$). The total adverse reaction rate during anesthesia recovery period in the study group was 5.77% (3/52), which was lower than that in the control group ($P < 0.05$). **Conclusion:** The application of anesthesia under BIS monitoring to elderly orthopedic surgery can reduce the dosage of anesthetics, improve the hemodynamic level and cognitive function, reduce the level of serum S100 β , promote postoperative recovery, and reduce adverse reactions.

Keywords bispectral index monitoring; elderly; orthopedics; hemodynamics; serum S100 β ; cognitive function; adverse reactions

术后认知功能障碍指的是患者在麻醉术后发生思维、认知、记忆等改变,其作为老年骨科患者术后高发并发症,会对患者术后机体恢复及生活质量造成严重影响^[1]。患者术后认知功能障碍与多种因素相关,其中术中麻醉深度为重要因素。因此术中对患者麻醉深度进行实时监测具有重要意义^[2-3]。脑电双频谱指数(bispectral index, BIS)作为脑电信号的一种分析方法,其可有效监测麻醉深度和大脑皮质功能状态,从而及时调整麻醉剂量,帮助患者术后麻醉恢复,尽可能避免认知功能障碍的发生^[4]。中枢神经特异性蛋白 β (S100 β)水平是评估中枢神经系统损伤的重要指标, S100 β 水平显著升高与麻醉深度相关^[5]。本研究对江阴市中医院收治的老年骨科手术患者,于术中应用BIS监测数据调节麻醉深度,分析其麻醉效果及对患者S100 β 水平的影响。

1 对象与方法

1.1 对象

采用两样本均数比较的样本含量估计研究所需的样本例数,公式如下: $N=4(t_{\alpha/2}+t_{\beta})^2s^2/\delta^2$, N 为两组样本总含量, I类错误 α 取0.05, II类错误 β 取0.10, $t_{\alpha/2}=1.960$, $t_{\beta}=1.282$, s 为两样本标准差, δ 为两总体均数之差。选择2018年2月至2022年2月江阴市中医院收治行老年骨科手术的104例患者,随机分为对照组与研究组,各52例。

对照组男30例,女22例,年龄为(70.96 \pm 4.73)岁,体重为(62.07 \pm 6.17) kg;美国麻醉医师协会(American Society of Anesthesiologists, ASA)分级:I级9例,II级24例,III级19例。骨折部位:髋关节骨折(股骨颈骨折、股骨转子间骨折)20例,膝关节骨折(髌骨骨折、胫骨平台骨折)15例,股骨粗隆间骨折17例。文化程度:小学及以下20例,中学27例,大学及以上5例;高血压16例,糖尿病13例,脑梗死6例。研究组男28例,女24例,年龄为(70.57 \pm 4.59)岁,体重为(61.82 \pm 6.34) kg;ASA分级:I级10例,II级22例,III级20例。骨折部位:髋关节骨折(股骨颈骨折、股骨转子间骨折)22例,膝关节骨折(髌骨骨折、胫骨平台骨折)16例,股骨粗隆间骨折16例。文化程度:小学及以下18例,中学28例,大学及以上6例。高血压17例,糖尿病12例,脑梗死8例。两组一般资料的差异均无统计学意义(均 $P > 0.05$)。

纳入标准:年龄 > 60 岁;经X线片、CT检查确诊为下肢骨折;麻醉方式均为全身麻醉者;患者及家属均签署知情同意书;均无宗教信仰。排除标准:合并严重脏器功能障碍;既往精神疾病不能配合;存在麻醉禁忌;长期服用镇静类或抗抑郁药物;术前简易智力状态检查量表(Mini-Mental State Examination, MMSE)^[6]评分 < 24 。本研究经江阴市中医院医学伦理委员会批准(审批号:LW2018011)。

1.2 方法

所有患者均在术前1 d禁饮禁食, 在进入手术室前30 min肌注硫酸阿托品注射液0.5 mg、苯巴比妥钠注射液0.1 g。进入手术室后建立外周静脉通道, 对患者血压、心率等指标进行监测。给予所有患者靶控泵输注0.5 μ g/kg枸橼酸舒芬太尼注射液, 1.5~2.0 mg/kg异丙酚注射液。在患者完全失去意识后静脉输注0.15 mg/kg苯磺阿曲库铵注射液, 给予患者气管插管, 调整呼吸频率为10~12次/min, 潮气量8~10 mL/kg, 呼气末CO₂分压35~45 mmHg (1 mmHg=0.133 kPa), 吸气与呼气比为1:1.5。静脉输注枸橼酸舒芬太尼、异丙酚注射液维持麻醉。对照组根据患者术中血流动力学指标水平及麻醉师经验调整麻醉剂用量。研究组在麻醉诱导前连接BIS麻醉深度监测仪, 麻醉期间对患者BIS值进行监测并调整麻醉剂量, 将BIS维持在45~60。

1.3 观察指标

1) 术中主要麻醉药物用量及术后恢复指标。观察并记录两组枸橼酸舒芬太尼注射液、异丙酚注射液用量、术后自主呼吸恢复时间、苏醒时间、拔管时间情况。2) 血流动力学。监测并记录两组麻醉前(T₀)、切皮时(T₁)、麻醉后45 min(T₂)、缝皮时(T₃)、拔管时(T₄)的心率(heart rate, HR)、收缩压(systolic blood pressure, SBP)、舒张压(diastolic blood pressure, DBP)、平均动脉压(mean arterial pressure, MAP)、血氧饱和度(oxygen saturation, SpO₂)指标。3) 血清S100 β 水平。采用酶联免疫吸附法监测两组术前、术后24、72 h血清S100 β 水平。4) 认知功能与谵妄情况。采用蒙特利尔认知评估量表(Montreal Cognitive Assessment, MoCA)评价两组术前、术后24、72 h认知功能, 共7个维度, 总分0~30, 评分 \geq 26则认知功能正常^[7]。采用谵妄诊断量表(the

Confusion Assessment Method, CAM)评估患者谵妄情况, 该量表包含11个条目, 总分11~44, 患者得分越高则表明谵妄症状越严重。5) 麻醉苏醒期不良反应。统计两组麻醉苏醒期寒战、术中知晓、躁动等发生率。

1.4 统计学处理

采用SPSS 22.0统计学软件进行分析。计量资料采用均数 \pm 标准差($\bar{x}\pm s$)表示, *t*检验; 计数资料采用例(%)表示, 比较采用Fisher确切概率法。*P*<0.05为差异有统计学意义。

2 结果

2.1 术中主要麻醉药物用量及术后恢复指标

研究组各麻醉药物用量均少于对照组, 术后苏醒时间、拔管时间均短于对照组(均*P*<0.05, 表1)。

2.2 血流动力学指标

研究组T₁、T₂、T₃、T₄的HR、SBP、DBP、MAP水平均低于对照组(均*P*<0.05, 表2)。

2.3 血清S100 β 水平

研究组术后24、72 h血清S100 β 水平均低于对照组(均*P*<0.05, 表3)。

2.4 MoCA及CAM评分

研究组术后24、72 h的MoCA评分均高于对照组, 术后24、72 h的CAM评分均低于对照组(均*P*<0.05, 表4)。

2.5 麻醉苏醒期不良反应

研究组麻醉苏醒期总不良反应发生率低于对照组(*P*<0.05, 表5)。

表1 两组术中主要麻醉药物用量及术后恢复指标比较(*n*=52)

Table 1 Comparison of main anesthetic dosage and postoperative recovery indexes between the 2 groups (*n*=52)

组别	枸橼酸舒芬太尼注射液/mg	异丙酚注射液/mg	术后自主呼吸恢复时间/min	苏醒时间/min	拔管时间/min
对照组	1.45 \pm 0.22	625.06 \pm 70.18	7.34 \pm 1.04	10.91 \pm 1.13	13.12 \pm 1.35
研究组	0.89 \pm 0.15	492.27 \pm 51.36	6.97 \pm 1.08	7.51 \pm 1.05	9.97 \pm 1.04
<i>t</i>	15.166	11.011	1.780	15.894	13.329
<i>P</i>	<0.001	<0.001	0.078	<0.001	<0.001

表2 两组各时间点血流动力学指标比较($n=52$)Table 2 Comparison of hemodynamic indexes at different time points between the 2 groups ($n=52$)

时间	组别	HR/(次·min ⁻¹)	SBP/mmHg	DBP/mmHg	MAP/mmHg	SpO ₂ /%
T ₀	对照组	74.15 ± 8.02	137.47 ± 7.02	82.77 ± 5.04	99.06 ± 8.92	98.55 ± 1.13
	研究组	73.97 ± 8.14	137.71 ± 6.97	82.41 ± 5.36	98.97 ± 8.96	98.47 ± 1.09
	<i>t</i>	0.114	0.175	0.353	0.051	0.367
	<i>P</i>	0.910	0.862	0.725	0.959	0.714
T ₁	对照组	76.08 ± 8.22	136.05 ± 6.47	78.27 ± 6.02	104.62 ± 9.13	98.72 ± 1.05
	研究组	65.41 ± 8.53	131.83 ± 6.50	72.05 ± 5.93	99.94 ± 9.26	98.38 ± 1.12
	<i>t</i>	6.495	3.318	5.308	2.595	1.597
	<i>P</i>	<0.001	0.001	<0.001	0.011	0.113
T ₂	对照组	81.94 ± 8.27	128.93 ± 7.03	76.13 ± 6.74	111.72 ± 8.47	97.85 ± 1.36
	研究组	70.03 ± 8.44	119.94 ± 6.82	64.05 ± 6.06	102.03 ± 8.51	97.47 ± 1.40
	<i>t</i>	7.268	6.619	9.611	5.820	1.404
	<i>P</i>	<0.001	<0.001	<0.001	<0.001	0.163
T ₃	对照组	85.96 ± 8.08	122.07 ± 7.41	74.28 ± 6.25	107.57 ± 8.29	98.29 ± 1.28
	研究组	69.17 ± 7.95	107.74 ± 7.93	62.78 ± 6.71	99.75 ± 8.11	98.07 ± 1.37
	<i>t</i>	10.681	9.521	9.043	4.862	0.846
	<i>P</i>	<0.001	<0.001	<0.001	<0.001	0.400
T ₄	对照组	89.82 ± 8.04	126.92 ± 6.58	75.18 ± 6.29	110.08 ± 7.82	98.03 ± 1.14
	研究组	71.89 ± 7.93	118.17 ± 5.94	71.27 ± 6.05	104.03 ± 7.75	97.94 ± 1.17
	<i>t</i>	11.449	7.118	3.231	3.963	0.397
	<i>P</i>	<0.001	<0.001	0.002	<0.001	0.692

1 mmHg=0.133 kPa.

表3 两组手术前后血清S100 β 水平比较($n=52$)Table 3 Comparison of serum S100 β before and after the operation between the 2 groups ($n=52$)

组别	术前/($\mu\text{g}\cdot\text{L}^{-1}$)	术后24 h/($\mu\text{g}\cdot\text{L}^{-1}$)	术后72 h/($\mu\text{g}\cdot\text{L}^{-1}$)
对照组	1.18 ± 0.31	1.92 ± 0.41	1.40 ± 0.34
研究组	1.20 ± 0.33	1.55 ± 0.39	1.12 ± 0.28
<i>t</i>	0.319	4.715	4.584
<i>P</i>	0.751	<0.001	<0.001

表4 两组手术前后MoCA及CAM评分比较($n=52$)Table 4 Comparison of MoCA and CAM scores before and after the operation between the 2 groups ($n=52$)

组别	MoCA评分			CAM评分		
	术前	术后24 h	术后72 h	术前	术后24 h	术后72 h
对照组	26.71 ± 2.55	18.16 ± 2.04	21.38 ± 2.11	15.52 ± 2.35	22.52 ± 3.78	19.17 ± 2.74
研究组	26.69 ± 2.58	21.13 ± 2.08	24.93 ± 2.06	15.37 ± 2.04	20.13 ± 2.61	16.81 ± 2.08
<i>t</i>	0.040	7.351	8.681	0.348	3.752	4.947
<i>P</i>	0.968	<0.001	<0.001	0.729	<0.001	<0.001

表5 两组麻醉苏醒期不良反应比较($n=52$)Table 5 Comparison of adverse reactions between the 2 groups during the recovery period of anesthesia ($n=52$)

组别	寒战/[例(%)]	术中知晓/[例(%)]	躁动/[例(%)]	总发生/[例(%)]
对照组	3 (5.77)	2 (3.85)	6 (11.54)	11 (21.15)
研究组	1 (1.92)	0 (0.00)	2 (3.85)	3 (5.77)
P	—	—	—	0.041*

*Fisher确切概率法。

*Fisher exact probability method.

3 讨论

老年人群由于机体代谢速度明显下降,且机体各组织器官功能已发生显著下降,因此老年手术患者相较于其他年龄段患者更易发生术后认知功能障碍^[8-9]。有相关调查^[10]结果表明老年术后发生认知功能障碍的比例大于41%。谵妄作为认知功能障碍中的严重类型,其通常因患者大脑活动失调而造成,在术后急性发作,会使患者意识水平及注意力明显降低,造成术后机体康复时间延长,部分患者可造成认知损伤,甚至死亡^[11-12]。高龄、合并疾病、认知功能明显降低、麻醉等均为患者术后谵妄的主要因素,临床无法对易感因素进行控制,因此在术中应尽可能调控诱发因素,从而降低谵妄发生率^[13-14]。老年患者对麻醉的耐受度较差,对麻醉要求更高,需给予患者合理麻醉,对其实施麻醉深度监测具有重要意义^[15]。本研究对老年骨折患者实施依据BIS监测数据调节麻醉深度取得了较好效果。

本研究观察到:研究组枸橼酸舒芬太尼注射液、异丙酚注射液用量均少于对照组,术后苏醒时间、拔管时间均短于对照组(均 $P<0.05$)。这表明依据BIS监测数据调节麻醉深度可有效减少麻醉药物使用量,避免患者术后苏醒延迟。分析原因主要为:BIS可测定脑电图线性成分,能够对成分波之间的非线性关系进行分析,进而挑选出不同镇静水平的脑电信号,并进行数据化处理,最终转化为一种简单的量化指标,从而有效监测患者大脑皮质的功能状态,预测患者在术中意识状况及体动情况^[16-17]。研究组根据BIS值指导异丙酚及枸橼酸舒芬太尼注射液的剂量,不仅能够保障患者血液稳定,还可控制麻醉药物用量,缩短术后苏醒时间及拔管时间^[18-19]。本研究发现:两组在各时间点的血流动力学指标水平均出现波动,但研究组各血流动力学指标(除 SpO_2 外)水平均低于对

照组(均 $P<0.05$)。这表明依据BIS监测数据调节麻醉深度可更好避免术中麻醉诱导造成老年患者血流动力学水平波动情况。分析原因为:在对患者实施麻醉诱导、手术操作等均会对其产生应激反应,从而引发血压波动,且老年患者波动幅度较大。而研究组通过监测BIS数据能够间接反映患者体内麻醉药物的浓度,从而有效指导患者异丙酚及枸橼酸舒芬太尼注射液的使用剂量,将血压等血流动力学水平保持较为稳定的状态^[20]。本研究观察到:研究组术后各时间血清 $S100\beta$ 水平及CAM评分均低于对照组,MoCA评分高于对照组(均 $P<0.05$)。这表明依据BIS监测数据调节麻醉深度可降低麻醉对患者认知功能及谵妄的影响。分析原因主要为: $S100\beta$ 作为神经系统特异性蛋白,其对中枢神经系统的稳定起重要作用;MoCA是目前评估脑功能的重要量表,可有效反映患者认知功能情况。依据BIS监测数据调节麻醉深度能够尽快改善患者术后血清 $S100\beta$ 水平及MoCA评分,缓解患者术后认知功能损伤。研究组麻醉苏醒期总不良反应发生率较对照组低,其原因与依据BIS监测数据调节麻醉深度可显著减少麻醉药物使用剂量相关,因此安全性较高。

综上所述,BIS监测下麻醉可减少老年骨科手术中麻醉药物用量,改善血流动力学水平及认知功能,降低血清 $S100\beta$ 水平,促进术后恢复,减少不良反应。但本研究不足之处在于所选样本量不足,且研究时间有限未能对BIS值与血清 $S100\beta$ 水平、MoCA评分的相关性进行分析,今后应扩大样本量作进一步研究。

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