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## 颅内压对外伤性脑损伤患者生存状况的影响

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**[摘要]** 目的: 探索颅内压(intracranial pressure, ICP)对外伤性脑损伤患者生存状况的影响。方法: 回顾性分析2015年3月至2018年3月于南部县人民医院接受治疗的132例外伤性脑损伤患者的临床资料, 根据患者出院后格拉斯哥预后分级(Glasgow outcome grading, GOS)评分结果分为预后良好组( $n=74$ )和预后不良组( $n=58$ )。收集患者ICP相关参数包括脑灌注压(cerebral perfusion pressure, CPP)、ICP均值、ICP波幅、压力反应指数(pressure response index, PR<sub>x</sub>)、ICP波幅与动脉压波幅相关系数(ICP-arterial blood pressure wave amplitude correlation, IAAC)、ICP相关系数(regression of amplitude and pressure, RAP)等临床资料, 对有统计学意义的相关因素行多因素Logistic回归分析, 采用SPSS 22.0软件计算ICP, PR<sub>x</sub>在不同阈值基线之上的曲线下面积。结果: 预后不良组ICP, PR<sub>x</sub>, IAAC均显著高于预后良好组, CPP显著低于预后良好组, 数据对比差异有统计学意义( $P<0.05$ ); 年龄、性别、入院时GOS评分、神经外科重症监护室(neurosurgical intensive care unit, NICU)入住时间、RAP对比差异无统计学意义( $P>0.05$ )。对影响外伤性脑损伤患者生存状况的因素进行多因素logistic回归分析, 结果显示ICP和PR<sub>x</sub>是影响外伤性脑损伤患者生存状况的独立危险因素( $P<0.05$ )。受试者工作特征(receiver operating characteristic, ROC)曲线显示D<sub>ICP20</sub>曲线下面积为0.69, D<sub>ICP22</sub>曲线下面积为0.72。D<sub>PRx0.25</sub>曲线下面积为0.98, D<sub>PRx0.05</sub>曲线下面积为0.95。两组患者均进行大骨瓣减压, 预后良好组术后发现再出血1例(1.35%), 预后不良组6例(10.34%); 预后良好组术后发现脑积水2例(2.70%), 预后不良组9例(15.52%), 差异有统计学意义( $P<0.05$ )。结论: ICP和PR<sub>x</sub>是影响外伤性脑损伤患者生存状况的独立危险因素, 对ICP和PR<sub>x</sub>不同阈值进行ROC曲线下面积计算可以作为判断外伤性脑损伤患者不良预后的参数, 且PR<sub>x</sub>作为参数计算准确性更高。

**[关键词]** 颅内压; 外伤性脑损伤; 生存状况

## Effect of intracranial pressure on survival of patients with traumatic brain injury

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**Abstract** **Objective:** To explore the effect of intracranial pressure (ICP) on the survival of patients with traumatic brain injury. **Methods:** The clinical data of 132 patients with traumatic brain injury who were treated in our hospital from March 2015 to March 2018 were analyzed retrospectively. The results were divided into good prognosis

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group ( $n=74$ ) and poor prognosis group ( $n=58$ ) according to the results of Glasgow outcome grading (GOS). ICP related parameters including cerebral perfusion pressure (CPP), ICP mean, ICP amplitude, pressure response index (PRx), ICP amplitude and arterial pressure amplitude correlation coefficient (IAAC), ICP correlation coefficient (RAP) were collected, and multiple factor Logistic regression analysis for statistically significant factors was performed by GP 6.0 software. The area under the curve of ICP and PRx over different threshold baselines. **Results:** ICP, PRx and IAAC in poor prognosis group were significantly higher than those in good prognosis group, and CPP was significantly lower than good prognosis group, and the data comparison was statistically significant ( $P<0.05$ ). There was no statistical difference between age, sex, GOS score at admission, NICU time and RAP contrast ( $P>0.05$ ). Multiple factors Logistic regression analysis on the factors affecting the survival of patients with traumatic brain injury showed that ICP and PRx were independent risk factors affecting the survival of patients with traumatic brain injury ( $P<0.05$ ). The receiver operating characteristic (ROC) curve showed that the area under the  $D_{ICP20}$  curve was 0.69 and the area under the  $D_{ICP22}$  curve was 0.72. The area under the  $D_{PRx0.25}$  curve is 0.98 and the area under the  $D_{PRx0.05}$  curve is 0.95. The patients in both groups underwent decompression of large bone flap. The prognosis was good in one group and the postoperative rebleeding was 1.35%. In the poor prognosis group, 6 cases were 10.34%. In the prognosis group, 2 cases of hydrocephalus were found to be 2.70%, the poor prognosis group found that 9 cases accounted for 15.52%, the data were statistically significant ( $P<0.05$ ). **Conclusion:** ICP and PRx are independent risk factors for the survival of patients with traumatic brain injury. The calculation of area under the ROC curve for different threshold of ICP and PRx can be used as a parameter to judge the bad prognosis of traumatic brain injury, and the accuracy of PRx as a parameter is higher.

**Keywords** intracranial pressure; traumatic brain injury; survival condition

颅内压(intracranial pressure, ICP)监测是一种能够快速、准确反应机体颅内压力的监测方法。ICP监测目前被广泛应用于神经外科患者,特别是重型颅脑创伤患者<sup>[1-2]</sup>。实时ICP监测对指导治疗及提高预后具有重要意义,并能降低住院期间创伤性脑损伤患者病死率<sup>[3-4]</sup>。有研究<sup>[5]</sup>指出:ICP相关参数包括脑灌注压(cerebral perfusion pressure, CPP)、ICP均值、ICP波幅、压力反应指数(pressure reactivity index, PRx)、ICP波幅与动脉压波幅相关系数(ICP-arterial blood pressure wave amplitude correlation, IAAC)、ICP相关系数(regression of amplitude and pressure, RAP)与颅内代偿空间、颅内血管状态、脑顺应性生理指标具有重要联系。本研究对南部县人民医院接受治疗的外伤性脑损伤患者ICP相关参数行回顾性分析,并探讨其与患者预后的关系。

## 1 对象与方法

### 1.1 对象

回顾性分析2015年3月至2018年3月于南部县人民医院接受治疗的132例外伤性脑损伤患者

的临床资料,根据患者出院后格拉斯哥预后分级(Glasgow outcome grading, GOS)评分结果分为预后良好组和预后不良组。预后良好组74例,其中男41例,女33例,年龄28~59( $46.32\pm 14.06$ )岁,病程3~12( $7.85\pm 1.42$ )d,血肿量( $79.32\pm 20.47$ )mL;预后不良组58例,其中男32例,女26例,年龄26~61( $45.89\pm 13.65$ )岁,病程4~12( $7.31\pm 1.50$ )d,血肿量( $75.16\pm 18.09$ )mL。所有患者性别、年龄、病程、血肿量等临床资料对比差异无统计学意义( $P>0.05$ ),具有可比性。纳入标准:1)患者有明确外伤史;2)患者确诊为急性外伤性脑损伤;3)患者术后即刻行有创动脉压、ICP等监测;4)患者年龄18~65岁;5)患者临床资料完整。排除标准:1)肝、肾严重功能性损伤者;2)存在凝血功能异常;3)合并恶性肿瘤患者;4)妊娠期、分娩期妇女。本研究经南部县人民医院医学伦理委员会审核通过,患者均知情同意。

### 1.2 方法

#### 1.2.1 临床资料收集与分组标准

临床资料收集:对患者年龄,性别,入院时GOS评分,神经外科重症监护室(neurosurgical

intensive care unit, NICU)入住时间, ICP, CPP, PRx, IAAC, RAP数据进行统计, 对比两组异同。患者均于入院后行开颅血肿清除及ICP探头植入术, 植入部位为侧脑室, 术后即行颅压监测系统(国产HY2850多产术脑科监护仪)监测, 操作过程严格按照标准流程; 患者同时行神经外科治疗。

分组标准: 按照患者出院时GOS评价量表<sup>[6]</sup>结果进行分组, 量表结果包括GOS I级、II级、III级、IV级, 其中GOS I, II级患者为预后不良组, GOS III级、IV级患者为预后良好组。

### 1.2.2 ICP 监测相关参数计算和定义

预处理DCR数据采集系统收集的原始数据并得到ICP, CPP, PRx, IAAC, RAP等各项相关参数。根据实时平均动脉压和实时ICP差值计算出CPP值; PRx为动脉压与ICP的相关系数(取值范围在-1~1)。D<sub>PRx</sub>定义及计算: 选取开始监测患者24 h的PRx数据并设置0.25和0.05 2个阈值, 计算2个阈值对应的PRx曲线下面积, 定义为0.25和0.05两个阈值上的D<sub>PRx</sub>(D<sub>PRx0.25</sub>, D<sub>PRx0.05</sub>)。D<sub>ICP</sub>的定义及计算: D<sub>ICP</sub>为ICP在一定阈值之上的曲线下面积; 选取开始监测患者后24 h的ICP数据, 并设置20和22 mmHg(1 mmHg=0.133 kPa)2个阈值, 采用GP 6.0软件计算ICP在该阈值基线之上的曲线下面积, 定义为20 和22 mmHg阈值上的D<sub>ICP</sub>(D<sub>ICP20</sub>, D<sub>ICP22</sub>)。

### 1.3 统计学处理

采用SPSS 23.0软件对数据进行统计分析。两组

计量结果比较采用t检验, 计数资料比较用χ<sup>2</sup>检验, P<0.05为差异有统计学意义。有统计学意义的相关因素行多因素logistic回归分析。

## 2 结果

### 2.1 外伤性脑损伤患者临床资料及 ICP 相关参数比较

预后不良组ICP, PRx, IAAC均显著高于预后良好组, CPP显著低于预后良好组, 差异有统计学意义(P<0.05); 年龄、性别、入院时GOS评分、NICU入住时间、RAP对比, 差异无统计学意义(P>0.05, 表1)。

### 2.2 影响外伤性脑损伤患者生存状况的多因素 logistic 回归分析

对影响外伤性脑损伤患者生存状况的因素进行多因素logistic回归分析, 结果显示: ICP和PRx是影响外伤性脑损伤患者生存状况的独立危险因素(P<0.05, 表2)。

### 2.3 不同阈值比较及其对患者预后预测能力评估

受试者工作特征(receiver operating characteristic, ROC)曲线结果显示: D<sub>ICP20</sub>曲线下面积为0.69, D<sub>ICP22</sub>曲线下面积为0.72(图1)。D<sub>PRx0.25</sub>曲线下面积为0.98, D<sub>PRx0.05</sub>曲线下面积为0.95(图2)。

表1 两组患者临床资料及ICP相关参数对比( $\bar{x} \pm s$ )

Table 1 Comparison of clinical data and ICP parameters between the two groups of patients ( $\bar{x} \pm s$ )

组别	年龄/岁	性别(男/女)	入院时GOS评分	NICU入住天数	
预后良好组	54.29 ± 21.15	41/33	8.56 ± 2.19	4.23 ± 0.98	
预后不良组	51.42 ± 19.78	32/26	7.43 ± 1.76	5.12 ± 1.12	
χ <sup>2</sup> /t	0.945	0.524	1.632	0.889	
P	0.298	0.429	0.112	0.384	
组别	ICP/mmHg	CPP/mmHg	IAAC*	PRx	RAP
预后良好组	13.94 ± 3.64	82.46 ± 23.45	0.01 (0.02)	0.13 ± 0.04	0.25 ± 0.10
预后不良组	26.47 ± 10.72	47.30 ± 14.15	0.14 (0.07)	0.49 ± 0.12	0.29 ± 0.08
χ <sup>2</sup> /t	3.769	5.987	3.127	5.876	0.731
P	0.002	0.001	0.006	0.001	0.465

\*Median (IQR).

表2 影响患者生存状况的多因素logistic回归分析

Table 2 Multivariate logistic regression analysis of survival status in patients

指标	$\beta$	SE ( $\beta$ )	Wald $\chi^2$	P	OR	95%CI
ICP	0.366	0.127	8.233	0.004	1.442	1.123~1.851
CPP	0.640	0.047	185.451	0.214	1.897	0.730~2.080
IAAC	0.687	0.066	106.046	0.126	1.989	0.745~2.267
PRx	1.102	0.468	5.544	0.018	3.012	1.203~7.541

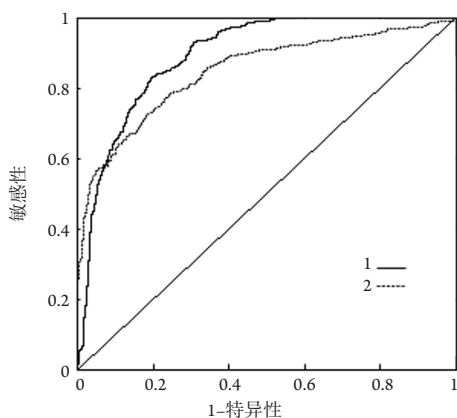


图1 20和22 mmHg 2个阈值的ICP判断预后的ROC曲线

Figure 1 ROC curve of ICP with 2 thresholds of 20 and 22 mmHg to determine prognosis

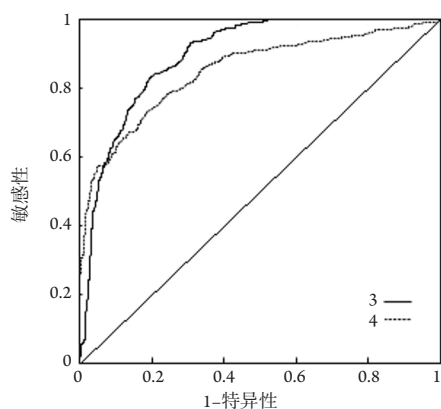
1:  $D_{ICP22}$ ; 2:  $D_{ICP20}$ .

图2 0.25和0.05 2个阈值的PRx判断预后的ROC曲线

Figure 2 ROC curve of prognosis judged by 2 thresholds of 0.25 and 0.05 for PRx

3:  $D_{PRx0.25}$ ; 4:  $D_{PRx0.05}$ .

#### 2.4 患者术后情况对比

两组患者均进行大骨瓣减压, 预后良好组术后发现1例(1.35%)术后再出血, 预后不良组发现6例(10.34%); 预后良好组术后发现2例(2.70%)脑

积水, 预后不良组术后发现9例(15.52%), 差异有统计学意义( $P < 0.05$ )。

### 3 讨论

ICP监测技术在我国不断发展, 应用范围不断推广, 而ICP相关参数在监测过程中的重要性也受到越来越多学者和临床医师的关注<sup>[7]</sup>。目前对ICP相关参数是否与患者不良预后存在相关关系、哪些参数关系更为密切、是否可以将其作为判断外伤性脑损伤患者预后的研究报道较少, 且尚未有明确的结论。本研究收集于南部县人民医院接受治疗的外伤性脑损伤患者ICP相关参数等临床资料进行回顾性分析, 并创新性地对不同阈值 $D_{ICP}$ 进行ROC曲线分析, 对比ICP和 $PR_x$ 的敏感度和特异性, 为临床上改善患者预后提供参考。

研究结果显示: 预后不良组ICP,  $PR_x$ , IAAC均显著高于预后良好组, CPP显著低于预后良好组, 该结果与文献[8-9]的结果基本一致, 与临床上提倡以ICP,  $PR_x$ , IAAC, CPP作为主要临床治疗依据基本一致; 年龄、性别、入院时GOS评分、NICU入住时间、RAP对比差异无统计学意义。有研究<sup>[10]</sup>认为: 以60~70 mmHg作为最佳CPP阈值范围, 能够提高预测准确性。且文献[11]指出: 当CPP超过70 mmHg可以改善外伤性脑损伤患者预后质量。但本研究中预后不良组患者CPP低于60~70 mmHg, 可能与患者不良预后有关。 $PR_x$ 是反映患者血管自主调节能力的相关参数, 当 $PR_x$ 为正值时则提示机体内脑血管床自主反应性消失, 当 $PR_x$ 为负值时则提示机体内脑血管自主调节能力较为良好<sup>[12]</sup>。IAAC同样可以作为反映机体脑血管自主调节功能的参数, 且IAAC与外伤性脑损伤患者早期预后密切相关<sup>[13]</sup>。本研究对影响外伤性脑损伤患者生存状况的因素进行多因素logistic回归分析, 结果显示: ICP,  $PR_x$ 是影响外

伤性脑损伤患者生存状况的独立危险因素。有研究<sup>[14]</sup>认为：以平均ICP参数作为单一判断外伤性脑损伤患者预后会存在信息不精确、不完整等问题，严重影响对患者外伤性脑损伤病情的正确判断，延误患者最佳治疗时机。但文献<sup>[15]</sup>报道：在平均ICP基础上进行一定阈值曲线下面积计算能够准确反映患者外伤性脑损伤的严重程度，并且能够较好地判断患者预后。本研究ROC曲线结果显示： $D_{ICP20}$ 曲线下面积为0.69， $D_{ICP22}$ 曲线下面积为0.72； $D_{PRx0.25}$ 曲线下面积为0.98， $D_{PRx0.05}$ 曲线下面积为0.95。 $D_{PRx}$ 具有较高的预测准确性，可以作为判断患者预后的理想指标。本次研究中预后不良组 $D_{PRx}$ 均显著高于预后良好组，可能原因是预后不良组患者存在长期脑血管反应较差。本次研究存在一定不足，如选取患者例数较少，导致样本数据具有一定片面性、未对患者远期预后进行跟踪随访统计等，需要在往后的研究中不断完善。

综上所述，ICP， $PR_x$ 是影响外伤性脑损伤患者生存状况的独立危险因素，对ICP， $PR_x$ 不同阈值进行ROC曲线下面积计算可以作为判断外伤性脑损伤患者不良预后的参数，且 $PR_x$ 作为参数计算准确性更高。

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