

CLINICAL STUDY OF RELATED FACTORS AND PSYCHOLOGICAL INTERVENTIONS IN PATIENTS WITH POST-CONCUSSION SYNDROME

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Running header: Clinical study of PCS after mTBI - ³Second Provincial People's Hospital of Gansu, Lanzhou, Gansu, China

ABSTRACT

Objectives: To analyze the related factors of post-concussion syndrome (PCS) after mild traumatic brain injury and to provide a clinical basis for the prevention and treatment of PCS.

Methods: Relevant data were collected from 67 patients diagnosed with PCS after mild traumatic brain injury and 30 patients who were asymptomatic after mild traumatic brain injury and who had been admitted to the Affiliated Hospital of Northwest University for Nationalities in China between August 2016 and June 2019. Logistic regression was used to identify the risk factors of PCS; 67 of the patients from Affiliated Hospital of Northwest University for Nationalities in China with PCS were randomly divided into two groups: a conventional drug group (32 patients) and a psychological intervention group (35 patients). Patients in both groups were subjected to conventional PCS drug treatments, while those in the psychological intervention group received both conventional treatment and psychological intervention. Both groups were evaluated using the Symptom Checklist 90 (SCL-90) and the Rivermead PCS Questionnaire (RPQ) at the beginning of the treatment and one month after treatment.

Results: violent injury, compensation or litigation, and occupation were found to be statistically significant. Specially, our research found that somatic symptoms significantly improved among the conventional drug group after treatment, while all aspects significantly improved among the psychological intervention group.

Conclusions: violent injury, compensation or litigation, and occupation were found to be the most important factors leading to PCS after mild traumatic brain injury. drug therapy combined with psychological intervention was shown to significantly promote recovery from PCS. It provides theoretical basis for early intervention and psychological intervention of PCS.

Keywords: mild traumatic brain injury, post-concussion syndrome, related factors, logistic regression analysis, psychological interventions.

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Introduction

Mild traumatic brain injury (mTBI) is a significant public health issue, with an estimated annual 42 million mTBI being sustained worldwide^(1,2). Even a conservative estimate of the prevalence of prolonged post-concussive symptoms (PCS, 10%-15% of mTBIs) suggests that there is a substantial and unrecognized burden of hundreds of thousands of new patients with such symptoms each year⁽³⁾. Symptoms such as headache, nausea, and blurred vision were originally thought to resolve within 7 to 10 days of sustaining the injury in the

vast majority (80%-90%) of patients⁽⁴⁾. However, in a small number of cases, symptoms persist and related functional impairment can reach 33% within three months and remain as high as 22% one year after the injury^(3,5). According to the International Classification of Diseases, 10th Revision (ICD-10) criteria for PCS, a person must have symptoms in at least three of six domains that persist for more than one month⁽⁶⁾. Quality of work, life, and family relationships can be seriously affected for PCS patients, leading to a great burden for themselves, their families, and society in general^(3,7). Some current research suggests that multiple etiologies

contribute to prolonged post-concussive symptoms, including psychogenic factors (e.g., coping style, mood, or anxiety disorders), cervicogenic factors (e.g., neck injury), and neurophysiological issues (e.g., cerebrovascular dysregulation, microscopic white matter damage)⁽⁷⁻⁹⁾. However, the pathogenesis of PCS remains unclear.

This study therefore explores the influencing factors in patients with PCS with the goal of providing a basis for preventing and reducing the occurrence of PCS. It does so by collecting data from 67 patients who were diagnosed with PCS after sustaining mTBI and 30 patients who were asymptomatic three months after having sustained mTBI and analysing these data using logistical regression analysis.

The study also seeks to understand the impact that psychological intervention has on PCS patients' prognoses by using psychological intervention methods in these patients' treatment regimens, and to provide a theoretical basis for psychological intervention in the treatment of patients with post-concussion syndromes.

Methods

Research objective

PCS patients were recruited from the emergency department, neurology department, neurosurgery department, and psychiatric department of the Affiliated Hospital of Northwest University for Nationalities in China between August 2016 and June 2019.

The ICD-11 criteria for PCS are as follows^(10,11):

A. Known personality and behavioral disorders (general criteria).

B. History of head trauma with loss of consciousness, preceding the onset of symptoms by a period of up to four weeks (objective evidence for brain damage may be lacking).

C. A PCS diagnosis must meet three of the following six criteria:

- Complaints of unpleasant sensations and pains, such as headache, dizziness (usually without the features of true vertigo), general malaise, excessive fatigue, or noise intolerance.

- Emotional changes, such as increased irritability or emotional lability that is easily provoked or exacerbated by emotional excitement or stress, or some degree of depression and/or anxiety.

- Subjective complaints of difficulty concentrating or performing mental tasks, or memory complaints without clear objective evidence

(via psychological tests, for example) of marked impairment.

- Insomnia.
- Reduced alcohol tolerance.
- Preoccupation with the above symptoms and fear of permanent brain damage, to the extent of hypochondriacal notions and the adoption of a self-diagnosed "sick" status. These symptoms must persist for three months after mild craniocerebral injury⁽¹²⁾.

Subsequently, patients' medical histories were examined to find out whether the patients fit the following inclusion criteria for having a documented mTBI:

- A doctor's visit within 24 hours of sustaining the injury, with a Glasgow Coma Scale (GCS) score⁽¹³⁾ of 13-15 points;

- Aged 16 to 75 years;

- Conforming to the diagnostic criteria of mTBI, as established by the American Congress of Rehabilitation Medicine (ACRM)^(14,15), which are: loss of consciousness (LOC) for <30 minutes; post-traumatic amnesia (PTA) for <24 hours; slight headache, dizziness, or other subjective symptoms; no signs of diffuse or focal damage in head CT scans of the nervous system; with or without skull fracture; no history of psychoactive substance use, mental disorder, hypertension, hyperlipidemia, diabetes, or other organic brain diseases;

- Voluntary participation in the study.

In total, 67 people were selected for this study.

Participant groups

Treatment group

This study classified 67 patients according to their serial numbers. Patients with PCS were enrolled in the psychological intervention group and the conventional drug treatment group using a random sampling method.

Conventional drug group: 14 males and 18 females, 38.7±5.6 years old, with a course of disease that was 17.2±4.6 months in duration;

Psychological intervention group: 15 males and 20 females, 41.2±5.3 years old, with a course of disease that was 15.3±2.7 in duration.

There was no statistical significance found in the general data for the two groups ($P > 0.05$).

Patients in the conventional drug treatment group received the following treatment: Ginkgo biloba injections of 19.6mg+ 10 mL compound brain peptide glucoside daily for 14 days. Patients were simultaneously given ibuprofen sustained-release

capsules, dexzopiclone tablets or vinamide sustained-release capsules, or flunarizine capsules according to their symptoms. The psychological intervention group received psychological treatments (five times for the patients and once for family members) on the basis of the conventional drug treatment. Both groups were scored on the SCL-90 and the RPQ before treatment and one month after treatment.

Control group

Patients with mild craniocerebral injuries sustained between August 2016 and June 2019 were randomly selected. Inclusion criteria were as follows:

- A doctor's visit within 24 hours or sustaining the injury, with a GCS score [13] of 13-15 points;
- Aged 16 to 75 years;
- Conforming to the diagnostic criteria of mBTI, as established by the ACRM^(16,17), which are: loss of consciousness (LOC) for <30 minutes; post-traumatic amnesia (PTA) for <24 hours; slight headache, dizziness, or other subjective symptoms; no signs of diffuse or focal damage in head CT scans of the nervous system; with or without skull fracture; no history of psychoactive substance use, mental disorder, hypertension, hyperlipidemia, diabetes, or other organic brain diseases;
- observable symptoms for three months after the mTBI.

In total, 30 patients were eventually selected for this study, with clinical follow-up taking place either online or offline. The flowchart of included subjects is shown in Figure 1.

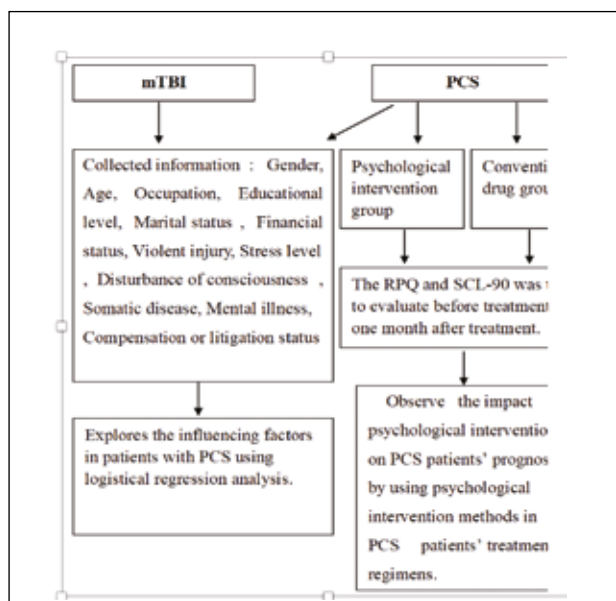


Figure 1: Flowchart of included patients in the current study.

Data collection

The patients or their legal guardians completed a general information questionnaire on their mTBI. The information that was collected included: gender, age, occupation, educational level, marital status, financial status, violent injury, stress levels (a self-reported level of how stressed the patient), disturbance of consciousness at time of injury, somatic disease before injury, mental illness before injury, and compensation or litigation status.

Observation indices for treatment group

SCL-90 was used to evaluate the patients' physical symptoms and mental state before treatment and one month after treatment. The scale consists of 90 items, including somatization, obsessive symptoms, interpersonal sensitivity, depression, anxiety, hostility, fear, paranoia, psychosis, and other factors that are measured on a five-point rating system. The patient was asked to make a self-assessment based on their state over the previous week.

The RPQ was also used with a total of 16 questions. RPQ scores were proportional to the severity of PCS⁽¹⁸⁾.

Quality control

Logic and completeness checks were performed on all data to eliminate errors, replication, and incomplete information. Valid data were then imported into an Excel file.

Statistical analysis

Unconditional logistic regression analysis was conducted for all possible influencing factors. Stepwise logistic regression analysis was then performed for the analysed significant variables. Univariate and multivariable odds ratios (OR) and associated 95% confidence intervals [95% CI] were reported for predictors. Measurement data for the two questionnaires were represented by $\bar{x} \pm s$ and by repeated analysis of variance (ANOVA), with $P < 0.05$ being considered statistically significant. Analyses were performed using Statistical Package for the Social Sciences (SPSS) version 25 (IBM Corporation, Chicago, IL).

Results

General

All of the patients enrolled in this study suffered mTBI. In total, 67 patients presented with PCS while

30 were asymptomatic after having sustained their initial injuries. The information that was collected included: gender, age, occupation, educational level, marital status, financial status, violent injury, stress level, disturbance of consciousness at time of injury, somatic disease before injury, mental illness before injury, and compensation or litigation status (see Table 1).

Factor	Variable name	Assignment instructions
Gender	X1	Male=0,Female=1
Age	X2	≤17=1,>17-40=2,>40-≥66=3,≥66=5
Occupation	X3	Unstable occupation=0,Stable career=1,
Educational level	X4	Illiterate=1,Primary school=2,Middle school=3,College degree or above=4
Marital status	X5	Unmarried=1,Married=2,Divorced=3
Financial status	X6	<3000 RMB=1,3000-5000 RMB=2,≥5000 RMB=3
Violent injury	X7	Yes =0, No=1
Stress level	X8	Low=0, Heavy=1
Disturbance of consciousness	X9	No=0, Yes=1
Somatic disease	X10	No=0, Yes=1
Mental illness	X11	No =0, Yes =1
Compensation or litigation status	X12	No=0, Yes=1
PCS	X13	No=0, Yes=1

Table 1: Assignment for relevant factors associated with PCS.

Unconditional logistic regression analysis results for PCS

Gender, age, occupation, educational level, marital status, financial status, violent injury cause, stress level, disturbance of consciousness at time of injury, somatic disease before injury, mental illness before injury, and compensation or litigation status were taken as independent variables. Patients PCS status was the dependent variable. An unconditional logistic regression analysis was performed to screen for which factors were significant in patients with PCS. As shown in Table 2, occupation (P = 0.022), financial situation (P = 0.001), violent injury (P = 0.001), and compensation or litigation status (P = 0.018) were more statistically significant (P< 0.05) than other factors.

Logistic stepwise regression analysis results for PCS

After the results of the unconditional logistic regression, a logistic stepwise regression analysis was performed on the factors that were found to be statistically significant. In order of OR, the independent factors were violent injury

(X7), compensation or lawsuit status (X12), and occupation (X3). (Tab 3).

Factor	Wald χ^2	P value	OR [95% CI]
Gender X1	0.811	0.368	0.655[0.261,1.644]
AgeX2	221.147	0.054	128.342[60.258,156.254]
Occupation X3	5.242	0.022	2.136[1.115,4.091]
Educational level X4	0.783	0.376	1.427[0.649,3.137]
Marital status X5	10.051	0.002	9.375[2.350,37.399]
Financial status X6	10.830	0.001	8.571[2.384,30.814]
Violent injury X7	10.281	0.001	0.488[0.315,0.757]
Stress level X8	3.686	0.055	2.500[0.981,6.371]
Disturbance of consciousness X9	1.459	0.277	1.815[0.690,4.773]
Somatic disease X10	2.420	0.122	0.471[0.182,1.216]
Mental illness X11	0.032	0.858	0.920[0.369,2.292]
Compensation or litigation status X12	5.610	0.018	0.317[0.123,0.820]

Table 2: Results of univariate logistic regression analysis of PCS patients.

Factor	B	S.E.	Wald χ^2	P value	OR[95% CI]
Violent injury X7	-0.717	0.223	9.281	0.005	0.379 [0.309,0.821]
Compensation or litigation status X12	-1.147	0.484	4.980	0.011	0.297 [0.203,0.920]
Occupation X3	-1.910	0.752	6.456	0.018	0.148 [0.034,0.646]

Table 3: Multivariate logistic regression analysis results for PCS patients.

Psychological intervention improve in patients with PCS

Menu	Conventional drug group(n=32)		Psychological intervention group(n=35)	
	Before treatment	After treatment	Before treatment	After treatment
Total score	302±15.57	288±18.97	301±14.78	227±19.14*
Divide the total	3.43±0.52	2.89±0.43	3.26±0.59	2.30±0.24*
Somatization	3.45±0.48	2.37±0.78*	3.25±0.78	2.06±0.89*
Forced symptoms	3.80±0.38	3.40±0.98	3.35±0.29	2.18±0.23*
Human relations	3.39±0.59	3.19±0.69	3.28±0.43	2.51±0.71*
Depression	3.42±0.48	3.03±0.72	3.54±0.76	2.31±0.38*
Anxiety	3.65±0.76	3.45±0.12	3.43±0.91	2.24±0.46*
Hostile	3.07±0.79	3.01±0.69	3.12±0.32	2.21±0.42*
Terrorist	3.28±0.89	3.04±0.21	3.08±0.89	2.58±0.31*
Paranoid	3.37±0.51	3.06±0.51	3.12±0.98	2.30±0.54*
Psychotic	3.23±0.24	3.13±0.74	3.20±0.24	2.23±0.64*
Other	3.15±0.24	2.78±0.56	3.11±0.34	2.15±0.94*

Table 4: SCL-90 evaluation results before and after treatment for both groups(n, $\bar{x}\pm s$).
*: Compared with the before treatment group, P<0.05

The SCL-90 results for PCS patients prior to treatment showed that scores for the following factors were higher in the case of patients with PCS: somatization, obsessive symptoms, depression, and anxiety. After a month of treatment, the somatic symptoms had improved for those in the conventional drug group ($P < 0.05$). Somatization, depression, anxiety, obsessive symptoms, interpersonal relationships, and other factors had significantly improved ($P < 0.05$) for those in the psychological intervention group (see Table 4).

For the PCS conventional treatment group, there was no significant difference in the RPQ scores between the pre-treatment and post-treatment. However, for the psychological intervention group, RPQ scores were significantly different between before and after treatment ($P < 0.05$) (see Table 5).

Group	n	RPQ scores	
		Before treatment	One month after treatment.
Conventional drug group		46±6.5	32±1.4
Psychological intervention group		45±7.2	27±1.4 *

Table 5: RPQ scores for both groups (n, ($\bar{x} \pm s$)).

*: Compared with the before treatment group, $P < 0.05$

Discussion

PCS is a common sequel of mTBI characterized by a series of subjective symptoms, including headache, dizziness, sensitivity to sound and light, fatigue and weakness, difficulty concentrating, poor memory, sleep disturbances, anxiety, and irritability occurring after sustaining mBTI^(6,7). However, a neurological examination of PCS patients shows no abnormalities⁽¹⁹⁾. The current definition of PCS is primarily based on standards found in ICD-10 and the fourth revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). Both sets of diagnostic criteria include a history of head trauma and state that symptoms must occur at least three times⁽¹²⁾. ICD-10 standards do not specify the duration of symptoms, while DSM-IV standards require that symptoms last for at least three months⁽²⁰⁾. The screening conditions for PCS in this study used a combination of these two sets of criteria. PCS diagnosis typically requires symptoms that fall into four categories⁽²⁰⁻²²⁾:

- Physical symptoms including headache, visual disturbances, dizziness, nausea, vomiting, difficulty balancing, photophobia, or misophonia.
- Cognitive symptoms including fatigue,

lethargy, difficulty concentrating, and poor cognition.

- Sleep symptoms including difficulty sleeping or sleeping more or less than usual.
- Emotional symptoms including becoming more emotional, sad, or irritable.

In general, symptoms of cerebral concussion change over time. One month after sustaining a concussion, the most common symptoms include headache, fatigue, and irritability. A study has suggested that the mean duration of PCS is six months⁽²³⁾, with 11%-29% of patients with concussion going on to develop PCS^(24,25). The mechanism of PCS remains unclear. Majority opinion holds that it is related to psychological and neurophysiological factors^(3,20). Research has suggested that demographic factors (being >6 years old, in adolescence, or female), symptoms at the time of injury (e.g., headache symptoms in an emergency department), a patient’s condition on admission, whether other serious injuries are involved, and previous history of concussion are risk factors associated with the development of PCS^(24,26,27).

Studies have shown that patients with a history of concussion, pre-illness or other mental disorders, psychiatric disorders, or a family history of migraine have higher incidence of PCS^(21,28). Our study showed via a regression analysis of the influencing factors of PCS that violent injury, compensation or litigation status, and occupation are influencing factors on the development of PCS after mTBI. It also showed that disturbance of consciousness, though a key criterion for the diagnosis of concussion, does not predict occurrence of PCS, which is consistent with other current research⁽²⁹⁾. Gender, age, educational level, marital status, economic status, stress level, somatic disease before injury, and mental illness before injury were not influencing factors in the case of PCS. These results differ from previous results, however, this may be related to our experimental design and small sample size^(18,20).

Our research also included a randomized, controlled study to observe the effectiveness of psychological intervention in patients with PCS. The primary methods of psychological intervention were, firstly, cognitive behavioural intervention: introducing patients and their families to basic knowledge about the disease and establishing a correct active cognitive model to address the previously incorrect cognition; Secondly, social and family intervention: encouraging the patient’s family and friends to communicate with the patient and establish a good social and family support

system to help them overcome their psychological concerns⁽³⁰⁻³²⁾. Patients' scores for SCL-90 (which measures somatization, obsessive symptoms, depression, anxiety, and other factors in patients with PCS) were higher in the psychological treatment group than in the conventional drug group. This may be because patients experience certain kinds of psychological stresses immediately after an acute mTBI event and because they do not know that PCS causes depression, anxiety, or other potentially unhealthy emotions^(31,33). A patient's physical symptoms may also be aggravated by external causes, such as personal disputes⁽³⁴⁾. In this study, there was no significant difference between PRQ scores before and after treatment in the case of the conventional drug treatment group⁽³⁵⁾. PCL-90 scores showed that patients' somatic symptoms and sleep disorders improved significantly, most likely because headaches, dizziness, and insomnia are most common immediately after a concussion. Longer-term symptoms may exacerbate cognitive and emotional symptoms⁽²⁹⁾. In the case of the psychological intervention group, PRQ scores before and after treatment showed no significant statistical difference.

Scores for each factor on the PCL-90 scale decreased, which reflects the effectiveness of psychological interventions. Psychological interventions can help patients better understand the disease, decrease negative perceptions of their injury, relieve their unhealthy emotions, alleviate somatic symptoms, build confidence that they will recover from the illness, enhance patient compliance, promote recovery, and better adapt and return to society^(29,36). Many patients suffer from a range of negative emotions due to a lack of or insufficient compensation^(34,37). This suggests that the emergence of PCS is also related to certain social factors⁽³⁷⁾. Offering individualized psychological counseling may also help alleviate patients' symptoms. Considering that PCS can cause mental and economic strain on family members, psychological guidance is also needed for family members⁽³⁷⁾. We should therefore improve cognition of PCS patients' family members, try to evince their cooperation, and to help patients recover more effectively. Moreover, some studies have found that comprehensive psychological interventions improve the effects of mBTI treatment, improving depression, anxiety, and other psychological symptoms as well as quality of life and prognosis⁽³⁸⁾.

Conclusions

In summary, study suggest that violent injury, compensation or litigation status, and occupation are influencing factors on the development of PCS after mTBI. It also showed that disturbance of consciousness, though a key criterion for the diagnosis of concussion, does not predict occurrence of PCS. Gender, age, educational level, marital status, economic status, stress level, somatic disease before injury, and mental illness before injury were not influencing factors in the case of PCS. These results differ from previous results, however, this may be related to our experimental design and small sample size. Drug treatment for patients with PCS can effectively alleviate physical symptoms, while psychological intervention can improve patients' depression, anxiety, and emotional. In the follow-up study, the experimental design will be improved, such as expanding the sample size, including fall injury, sports-related injury and other influencing factors for PCS, so as to achieve early warning of PCS and early intervention for PCS.

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