

Observation on the Clinical Effect of Different Pressures in Hyperbaric Oxygen Therapy on Patients with Diffuse Axonal Injury

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Abstract: *Objective:* To observe the efficacy and significance of hyperbaric oxygen at different pressures in the treatment of diffuse axonal injury (DAI). *Methods:* Sixty patients with DAI were randomly divided into 1.8 ATA group (30 cases) and 2.2 ATA group (30 cases). The routine treatment for each group was the same. The 1.8 ATA group received hyperbaric oxygen therapy under 1.8 ATA on the basis of routine treatment, whereas the 2.2 ATA group received hyperbaric oxygen therapy under 2.2 ATA on the basis of routine treatment. The therapy was given once a day over 3 consecutive courses, with each course having 10 sessions. The Glasgow Coma Scale (GCS) on day 10, day 20, and day 30 after treatment, as well as the Glasgow Outcome Scale (GOS) after 6 months were compared between the two groups. *Results:* The mean GCS on day 10, day 20, and day 30 after treatment, as well as the mean GOS after 6 months of treatment in the 2.2 ATA group were significantly higher than those in the 1.8 ATA group ($p < 0.05$). *Conclusion:* For patients with diffuse axonal injury, hyperbaric oxygen therapy is more effective with 2.2 ATA compared with 1.8 ATA.

Keywords: Diffuse axonal injury; Hyperbaric oxygen therapy; Different pressures; Clinical efficacy

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1. Introduction

Diffuse axonal injury (DAI) is a type of brain injury caused by the inertial force of acceleration and/or deceleration. The diffuse damage of axons is mainly caused by a blunt force on the head, which is characterized by extensive axonal injury. It is common in motor vehicle accidents and falls. Disturbance of consciousness is a typical clinical manifestation. This condition is critical. The clinical disability rate and mortality rate are high, accounting for about 35%, with poor prognosis ^[1]. At present, there is no specific treatment method. However, in recent years, the wide application of hyperbaric oxygen therapy provides an effective way for the treatment of DAI. With clinical verification, hyperbaric oxygen therapy has shown good effects on the recovery of craniocerebral injury, cerebral ischemia, and stroke ^[2]. However, there are only a few studies on the therapeutic effect of hyperbaric oxygen at different pressures in the treatment of craniocerebral injury ^[3,4]. The research on the effect of hyperbaric oxygen therapy itself is lacking ^[5,6]. In order to seek a more active and effective therapeutic effect, 60 patients with DAI in the Affiliated Hospital of Hebei University were selected as the research subjects. The clinical efficacy of hyperbaric oxygen at different pressures in the treatment of diffuse axonal injury was investigated in order to provide reference

for clinical treatment.

2. Data and methods

2.1. Clinical information

A total of 60 patients with diffuse axonal injury treated in the Affiliated Hospital of Hebei University from February 2018 to August 2019 were recruited in this study. There were 34 male patients and 26 female patients, age ranging from 13 to 61. All the patients were admitted to the hospital within 1 hour to 24 hours after injury, with GCS less than 8. After admission, they were diagnosed as DAI based on computed tomography (CT) scan and clinical manifestations. The patients were divided into two groups: 30 cases in the 1.8 ATA group and 30 cases in the 2.2 ATA group. The two groups showed no significant difference in terms of age, gender, course of disease, and complications ($p > 0.05$).

2.2. Treatment methods

Both groups were given hydration therapy, anti-infectives, hormonal therapy, and consciousness-regaining therapy; the patients respiratory tract were kept unobstructed with tracheotomy if necessary. In addition to the aforementioned treatment, the 1.8 ATA group received 1.8 ATA hyperbaric oxygen therapy, while the 2.2 ATA group received 2.2 ATA hyperbaric oxygen therapy. The Yc2470/0.3-101v multi-person air pressurization chamber was used. The pressurization time was 20 minutes and 30 minutes, respectively, with stable pressure oxygen inhalation for 60 minutes, and the decompression time was 20 minutes and 30 minutes, respectively. The therapy was given once a day over three courses, with each course having 10 sessions, and a three-day rest between two courses.

2.3. Evaluation indicators

The Glasgow Coma Scale of the 1.8 ATA group and 2.2 ATA group were compared and analyzed [7,8]. The efficacy of hyperbaric oxygen at different pressures were evaluated based on the scores from Glasgow Coma Scale (GCS) on day 10, day 20, and day 30 after treatment, as well as the scores from Glasgow Outcome Scale (GOS) after 6 months. Glasgow Outcome Score criteria: (1) 5 points for good recovery; (2) 4 points for moderate disability; (3) 3 points for severe disability; (4) 2 points for vegetative state; (5) 1 point indicating death.

2.4. Statistical analysis

SPSS 17.0 was used to analyze the data. T-test was used for measurement data, while X^2 test was used for count data. The data were expressed in mean \pm standard deviation ($\bar{x} \pm s$). $p < 0.05$ indicates a statistically significant difference.

3. Results

3.1. Comparison of GSC between the two groups

The GCS scores of the 2.2 ATA group increased on day 10, day 20, and day 30, which were significantly different from those of the 1.8 ATA group ($p < 0.05$) (Table 1).

Table 1. Comparison of GSC scores between the two groups after treatment ($\bar{x} \pm s$)

Evaluation time	GCS score	
	1.8 ATA group	2.2 ATA group
Day 10	7.86 ± 2.12	8.89 ± 3.08
Day 20	8.62 ± 2.36	10.32 ± 3.68
Day 30	11.82 ± 3.16	13.96 ± 2.88

Comparing the two groups, $p < 0.05$

3.2. Comparison of GOS scores between the two groups

The GOS score of the 2.2 ATA group was better than that of the 1.8 ATA group ($p < 0.05$), as shown in **Table 2**.

Table 2. Comparison of GOS scores after 6 months of treatment between the two groups (%)

Group	Number of cases	Good	Bad
1.8 ATA group	30	16 (53.3%)	14 (46.7%)
2.2 ATA group	30	22 (73.3%)	8 (26.7%)

Comparing the two groups, $p < 0.05$

4. Discussion

Diffuse axonal injury (DAI) is the shearing of axons and rupture microvessels in various parts of brain under the action of shear force when the head is subjected to linear or rotational acceleration. It is common in traffic accidents, high-altitude falls, and violent situations. Clinically, if diffuse axonal injury is not diagnosed and treated in time, it may further develop into progressive intracranial hypertension, aggravate brain tissue lesions, and eventually lead to brain herniation and even central nervous system failure^[9,10]. At present, the treatment of brain edema and the control of secondary brain injury are the key to the treatment of diffuse axonal injury. The focus is mostly on relieving brain edema, reducing intracranial pressure, and preventing secondary brain damage. However, these treatment measures have failed to improve the prognosis of these patients^[10,11].

Hyperbaric oxygen therapy is an adjuvant therapy that has been developing rapidly in recent years. At present, it is mainly used in the treatment of ischemic and hypoxic conditions as well as brain trauma. The use of hyperbaric oxygen therapy in DAI is mainly to reduce brain edema and promote nerve repair by increasing the oxygen content in the body. Hyperbaric oxygen therapy can increase blood oxygen concentration and interstitial oxygen dispersion as well as improve cerebral hypoxia^[12,13]. Patients with DAI often have extensive swelling of the cerebral hemisphere, general dilation and congestion of cerebral vessels, significant increase of cerebral blood flow, and increase in brain stem volume^[14,15]. Hyperbaric oxygen therapy can constrict cerebral blood vessels and reduce cerebral blood flow, vascular permeability, exudation, cerebral edema, as well as intracranial pressure^[15,16]. While hyperbaric oxygen reduces cerebral blood flow, it increases the blood flow in the vertebral arteries and the partial pressure of oxygen in the reticular activation system and brainstem, as well as improves the hypoxic state of the reticular ascending activation system, which is conducive to improving the arousal state and promoting the recovery of consciousness^[16,17]. Clinical studies have shown that initiating hyperbaric oxygen therapy as soon as possible after DAI can effectively reduce mortality and improve the prognosis of patients^[18,19]. At present, when hyperbaric oxygen is used to treat craniocerebral injury, the pressure is often set to 1.8 to 2.5 ATA. However, there are few relevant studies on the therapeutic effects of hyperbaric oxygen at different

pressures.

The results of this study showed that the GCS on day 10, day 20, and day 30 after treatment as well as the GOS after 6 months in the 2.2 ATA group were significantly higher than those in the 1.8 ATA group. The GCS score reflects the change of consciousness after injury. The score of the 2.2 ATA group was higher than that of the 1.8 ATA group, suggesting that hyperbaric oxygen therapy at a higher pressure has more effect in promoting the recovery of consciousness and brain function. Secondary injury after DAI is an important factor affecting the prognosis of patients. Therefore, the use of 2.2 ATA hyperbaric oxygen therapy after DAI can reduce the complications of craniocerebral injury, reduce the mortality of patients, and improve their quality of life.

5. Conclusion

In conclusion, the use of hyperbaric oxygen therapy in diffuse axonal injury helps in repairing sheared axons, prevents the aggravation of secondary brain injury, promotes the recovery of neurological function, and significantly improves the prognosis of patients with diffuse axonal injury. Moreover, the 2.2 ATA hyperbaric oxygen therapy has a significant effect on stress management, which has substantial clinical application value and thus is worth popularizing.

Disclosure statement

The authors declare no conflict of interest.

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