



TO STUDY THE ROLE AND EFFICACY OF NEUROHYPERBARIC OXYGEN THERAPY IN PATIENTS WITH HEAD INJURY IN A TERTIARY CARE HOSPITAL.

General Surgery

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ABSTRACT

Traumatic brain injury (TBI) is a major health problem worldwide, resulting in significant morbidity, mortality and the survivors are often left with cognitive and behavioural disabilities. Various treatment options in TBI are focussed on altering the secondary brain injury. Hyperbaric oxygen therapy (HBOT) is one such adjunctive treatments for TBI, which addresses the TBI induced ischemia and hypoxia.

The present study was conducted to assess the role and efficacy of HBOT in patients with head injury mainly in terms of improvement of consciousness and cognitive functions. The study also assessed the level of disability and the level of recovery in patients with traumatic brain injury, immediately post therapy.

A total of 120 patients with mild and moderate TBI were included in the present study, 60 patients each in the study or HBOT group and the control group.

Depending upon the clinical and radiological findings of the patients, the HBOT/study group received medical management and HBOT, whereas the control group received only medical management. The improvement in level of consciousness was assessed by Glasgow coma scale (GCS) score, Full outline of Unresponsiveness (FOUR) score. The level of cognitive improvement is assessed by the Ranchos Los Amigos scale and Montreal Cognitive assessment score. The level of disability was assessed by Disability Rating Scale (DRS) and the level of recovery was assessed by Glasgow Outcome Scale (GOS) and Glasgow Outcome Scale Extended (GOS-E)

The HBOT group showed significant improvement in the level of consciousness when compared to the control group. In terms of cognitive improvement, mixed results were obtained. However, there was no significant difference in the level of disability and recovery post therapy in both the groups.

KEYWORDS

Traumatic brain injury, Head injury, Hyperbaric oxygen therapy, Glasgow coma scale, Montreal Cognitive assessment score, Glasgow outcome scale.

INTRODUCTION

Traumatic brain injury (TBI) is a non-degenerative, non-congenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical, and psychosocial functions, with an associated diminished or altered state of consciousness.

The pathophysiology of traumatic brain injury includes a primary mechanical injury which occurs at the time of trauma.^[1] However, following the primary mechanical injury to the brain, secondary injury frequently develops^[1]. This secondary injury is precipitated by ischemia resulting from decreased cerebral blood flow (CBF) leading to hypoxia and is likely to occur in the first 24 hours after injury. Because of decreased oxygen (O₂) delivery to brain cells, the brain converts from aerobic to highly inefficient anaerobic metabolism, resulting in inadequate energy production in the brain and eventual cell death. Due to the diffuse nature of injury, affecting multiple brain areas, cognitive impairments are usually the predominant symptoms. Global brain hypoperfusion, and its related tissue ischemia, detected in patients suffering from TBI, serves as a rate-limiting factor for any regenerative process.^[2]

Hyperbaric oxygen therapy (HBOT) targets TBI-induced ischemia by exposing patients to an environment that substantially increases the amount of O₂ inspired (100% O₂ at >1 atmosphere absolute [ATA]), producing an increased O₂ concentration in the plasma and thus increased delivery of O₂ for diffusion to brain parenchyma. By increasing the oxygen level in blood and body tissues, HBOT can augment the repair mechanisms.

MATERIALS AND METHODS

Patient Profile:

This was a prospective study conducted over a period of 18 months. All

the patients with traumatic brain injury between the age of 18-80 years were included in the study group. The patients with traumatic brain injury of the age group 18-80 years not consenting to HBOT, with contraindication to HBOT and those who could not be weaned off the ventilator were included in the control group.

Procedure:

All the patients underwent a thorough clinical evaluation, assessment of the GCS, FOUR score, Ranchos Los Amigos scale, Montreal cognitive assessment score. The patients were then subjected to radiological evaluation either by Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) of the brain. The study group after thorough evaluation, were subjected to HBOT along with medical management. The number of sessions of HBOT depended on the clinical, radiological finding of the patient and the clinical response to therapy. The control group were managed conservatively with medical management as per their clinical and radiological findings. Post therapy, GCS, FOUR score, Ranchos Los Amigos scale, MoCA scores, DRS, GOS, GOS-E were assessed and tabulated.

RESULTS:

Patient's characteristics: A total of 120 patients were included in the present study, 60 patients each in the study/HBOT group and the control group. The mean age of the patients was 39 years and there were 66.35% males in the present study. The most common mechanism of trauma in both the groups were Road Traffic Accidents (RTA) and the most common history of presentation was Loss of consciousness. The patient characteristics, and the data collected are summarised in table 1.

Table 1 Showing Patient Characteristics In Both The Study And

Control Groups

Characteristic	HBOT group	Control group	
Mean Age	37.35 years ±13.61 years	41.5 ±14.95years	
Percentage males	80	74.4	
Most common mechanism of trauma	RTA	76.7%	61.7%
	Fall from height	20%	29.7%
	Assault	1.7%	6.4%
	Fall under the influence of alcohol	0	2.1%
Most common history on presentation	Trauma by a blunt object	1.7%	0
	No positive history of signs of head injury	18.3%	0
	LOC	76.7%	68.1%
	Headache	0	27.7%
Radiological findings	Giddiness	1.7%	0
	Projectile vomiting	3.4%	4.3%
	Hemorrhagic contusions	61.6%	36%
	EDH	15%	23%
Duration of admission	SDH	15%	29%
	DAI	18%	4%
	SAH	6%	25%
	24.28+ 13.45 days	17.41+7.99 days	

The most common radiological finding in both the group was hemorrhagic contusions. The mean duration of admission in the HBOT and control group were 24.28±13.45 days and 17.32±7.99 days respectively.

Outcome measures: the outcome measures of both the groups are tabulated and displayed in Table 2.

Table 2 Showing The Outcome Measures In Both The Study/ HBOT And Control Groups.

OUTCOME MEASURES	AT THE TIME OF ADMISSION			AT THE TIME OF DISCHARGE		
	HBOT	Control	P value	HBOT	Control	P value
Mean GCS	11.07±2.09	11.56 ±2.1	0.125	13.45 ± 2.68	11.96± 1.76	0.04
Mean FOUR score	13.05±2.27	13.61 ±1.92	0.076	14.88± 2.713	13.8±3 .177	0.009
Most frequent level in Ranchos Los Amigos level scale	Level 3	Level 4	0.001	Level 8	Level 7	0.001
Mean MoCA score	20.47±1.46	21.1± 2.59	0.238	23.96± 2.39	23.42± 2.12	0.279

It is evident from the above table that post therapy there is significant improvement in level of consciousness in the HBOT group when compared to the control group which is measured by the GCS score and FOUR score.

Cognitive parameter was assessed by the Ranchos Los Amigos scale level and the Montreal Cognitive Assessment score. The ranchos Los amigos scale level demonstrated significant cognitive improvement in the HBOT group when compared to the control group. MoCA score though improved satisfactorily in both the groups was not statistically significant.

Level Of Disability

Table 3 Comparing The Level Of Disability In Both The Study And Control Groups.

DRS (Disability rating scale)	HBOT	Control
<6 (Moderate Disability)	55.9%	45%
6-11 (Moderately severe disability)	37.3%	52.5%
12-16 (Severe disability)	5.1%	2.5%

>16 (Extremely severe disability)	1.7%	0%
Total	100%	100%

Though there is significantly lesser disability post therapy in HBOT group when compared to the control group, this was not statistically significant.

Level of Recovery:

Table 4 Comparing The Level Of Recovery Between The Study And The Control Group.

	HBOT (n=60)	Control (n=60)	P value
GOS (Glasgow Outcome Scale)			
3	15%	12.8%	0.719
4	16(26.7%)	29.8%	
5	56.7%	42.6%	
GOSE (Glasgow outcome scale extended)			
3	8.3%	2.1%	0.349
4	5%	10.6%	
5	8.3%	8.5%	
6	18.3%	21.3%	
7	20%	23.4%	
8	36.7%	19.1%	

There is significant recovery in both the groups as assessed by the GOS and the GOS-E, but however this is not statistically significant.

Complications:

Table 5 Showing The Residual Deficits And Percentage Mortality In The Study And Control Groups.

Residual deficits	HBOT group	Control group
Hemiplegia	6.7%	18.4%
Facial palsy	5%	10.6%
Slurring of speech	5%	23.4%
Generalised weakness	0%	8.5%
Bladder Incontinence	2.3%	2.1%
Amnesia	1.7%	0%
Aphasia	1.7%	0%
Percentage Mortality rate	1.7%	14.89%

The most common residual deficit seen post therapy was hemiplegia in both the HBOT and control groups, which is higher in the control group. The percentage mortality was higher in the control group when compared to the HBOT group.

DISCUSSION:

Traumatic brain injury (TBI) is a non-degenerative, non-congenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical, and psychosocial functions, with an associated diminished state of consciousness. The pathophysiology of traumatic brain injury includes two components, primary injury which occurs at the time of impact/ injury and secondary injury which is quite delayed and includes a chain of events causing further injury to the brain.^[1] All the treatment modalities are directed towards preventing further damage caused by secondary injury.

The specific mechanism of traumatic brain injury includes cerebral hypoperfusion^[3], cerebral vasospasm^[4], cerebral metabolic dysfunction^[5], changes in cerebral oxygenation, excitotoxic and oxidative stress.

HBOT is part of the therapeutic armamentarium to manage traumatic brain injury. HBOT in TBI acts by 1) increasing tissue oxygenation; 2) reducing inflammation^[6]; 3) decreasing apoptosis^[7]; 4) reducing intracranial pressure^[8]; 5) promoting neurogenesis and angiogenesis.

The literature was thoroughly reviewed in view of published data studying the efficacy of combined HBOT and medical management versus medical management alone.

The largest study was conducted by Rockwood et al.^[9] with 166 patients with 84 patients in the hyperbaric group and 82 patients in the

control group. 122 patients were males with 44 patients being female. The mean age of the patients in this study was 32.5 years. There were 77% and 71% males in the HBOT and control groups. Hyperbaric oxygen was administered to the treatment group in a monoplace chamber every 8 hours for 1 hour at 1.5 ATA in this treatment course continued for 2 weeks. The mortality was 17% and 32% in the HBOT groups and the control groups respectively. At 6, 12, and 18 months after injury, each patient was assessed for the level of recovery by GOS. The functional recovery as measured by GOS, did not show satisfactory improvement in both the groups.

Another study was conducted by Mao et al.^[10] which included 60 patients with 30 patients each in the HBOT and control group. The patients with traumatic brain injury with GCS less than 8 were admitted. The mean age in the HBOT group and control group were 40.9 and 39.8 years. 73.3% and 66.7% are males in the HBOT and control group respectively. GCS at the time of admission was noted. The GCS post therapy was noted in both the groups. The mean GCS in the HBOT group improved from 6 at the time of admission to 12.6 post therapy. Meanwhile in the control group, the mean GCS improved from 6.3 at the time of admission to 10.1 at the time of discharge. The improvement in GCS in the HBOT group was higher than in the control group and this was statistically significant.

In the study conducted by Lin et al.^[11] 44 patients were included in the study, with 22 patients randomly assigned into HBOT and control group. Patients with traumatic brain injury with GCS between 3 and 12 were included in the study. The patients in the HBOT group were subjected to 2ATA pure oxygen, 2 h once a day for 20 days over 4 weeks. The patients in the HBOT group were subjected to 2ATA pure oxygen, 2 h once a day for 20 days over 4 weeks. The mean GCS improved from 11.1 to 13.5 in the HBOT group and 10.4 to 11.5 in the control group. In this study, level of recovery, post TBI was assessed by assessing the GOS at the time of discharge, at 3 months and 6 months post trauma. There was 54.5% and 40.9% improvement in the GOS levels in the HBOT and control group from the time of discharge to 6 months. This was not statistically significant.

The current study included 120 patients with 60 patients each in the HBOT group and the control group. The mean age of patients in HBOT and control groups were 37.35 years and 41.5 years respectively. The percentage males in HBOT and control groups were 80% and 74.4% respectively. The mean duration of admission was 24.2 and 17.4 days respectively in the HBOT and the control group. The most common mechanism of injury was road traffic accidents and the most common history on presentation included Loss of consciousness in both the groups. The most common radiological finding was hemorrhagic contusions.

The study group after thorough evaluation were subjected to alternate day HBOT with an average pressure of 8.3 psi (pounds per square inch) along with medical management for traumatic brain injury. The control group received medical management alone.

The mean GCS in the study/HBOT group improved from 11.07 to 13.45, whereas in the control group it increased from 11.56 at the time of admission to 11.96 post therapy. The FOUR score in the HBOT group improved from 13.05 at the time of admission to 14.88 post therapy, whereas the control group improved from 13.61 to 13.8. Rancho Los Amigos levels in the HBOT group improved from majority of the patients being in level 3 to level 8, and in the control group it improved from most of the patients being in level 4 to level 7. The MoCA scores improved from 20.47 to 23.96 in the HBOT group and 21.1 to 23.42 in the control group. The level of disability in most of the patients in the HBOT group was moderate and it was moderately severe in the control group, but this wasn't statistically significant. The level of recovery measured by GOS and GOSE also didn't show significant difference in both the groups. The percentage mortality was higher in the control group compared to the study group.

CONCLUSIONS:

In the present study, HBOT acts as an adjunctive therapy to improve the level of consciousness in patients with traumatic brain injury as seen by the significant improvement in GCS and FOUR score in the study group. In terms of cognitive improvement, mixed results were obtained, that is, improvement was seen in the Rancho Los Amigos scale and not in the MoCA scores. It can be concluded that further assessment with other cognitive scales is required, as cognitive

assessment by MoCA was not possible in many patients due to their altered consciousness. Level of disability and recovery did not differ immediately post therapy, however long term follow up has to be conducted to accurately assess the level of disability and recovery.

Hyperbaric Oxygen therapy is a very good adjunctive therapy along with medical management to reduce the consequences of secondary brain injury post trauma. By thorough screening of the patients, the side effects and complications of HBOT can be avoided. This study is limited by small sample size and lack of follow up. Multicentric studies should be conducted to overcome this and to accurately elaborate the efficacy of HBOT.

ABBREVIATIONS

HBOT: Hyperbaric Oxygen Therapy

TBI: Traumatic Brain Injury

O₂: Oxygen

GCS: Glasgow Coma Scale

FOUR: Full Outline of UnResponsiveness

DRS: Disability Rating Scale

GOS: Glasgow Outcome Scale

GOS-E: Glasgow Outcome Scale-Extended

ATA: Atmosphere Absolute

CT: Computed Tomography

MRI: Magnetic Resonance Imaging

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