THE EFFECT OF HYPERBARIC OXYGEN THERAPY IN THE MANAGEMENT OF APHASIC PATIENTS

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ABSTRACT:

Background*: The rehabilitation of aphasic patients encompasses several areas of intervention and rehabilitation including medical treatment, physical, occupational therapy and psychological counseling. The central part of rehabilitation program is language therapy.*

In this study hyperbaric oxygen (HBO) was used as an adjuvant to the existing therapeutic management for patients with acute or completed stroke hoping that it will be beneficial for patients.

Aim of the work: *is to evaluate effect of hyperbaric oxygen therapy (HBOT) as a recent tool in management of aphasia in order to highlight this therapeutic technique.*

Patients and methods: *This study was applied on 30 patients with age ranging from 40 - 60 years, from January 2018 to September 2021, diagnosed with ischemic stroke, based on objective and clinical measures recruited from the outpatient Phoniatric clinic at Ain Shams University Hospitals, and Kobree el kobba military hospital.*

The patients were distributed randomly into two groups. Group I, receiving only language therapy sessions. Group II, receiving both language therapy sessions and adjuvant HBO therapy.

Results: *Comparing pre and post therapy results, there was statistically significant difference between before and after language therapy, and statistically significant difference between before and after language and hyperbaric oxygen therapy.*

There were statistically significant differences and higher means/standard deviations among patients who received language therapy with HBO therapy than those who received language therapy only.

Conclusion: *The present study showed that hyperbaric oxygen is effective in treatment of aphasia after stroke not only the language therapy. So, it can be considered one of the protocol of treatment in stroke patients with aphasia and Language problems.*

Keywords: *Hyperbaric Oxygen Therapy, Stroke, Aphasia.*

INTRODUCTION:

Stroke is a leading cause of death and disability It is more common in older individuals but also occurs in young adults and children.[1]

While stroke mortality rates are decreasing due to improved medical treatment of the complications caused by acute stroke, the number of individuals living with the residual effects of stroke is rising.[2]

Currently, over 75% of patients survive a first stroke, and, of these individuals, 25% are left with a minor disability and 40% experience moderate-to-severe Disabilities[3]

Approximately two thirds of stroke survivors have a communication disorder which significantly affects functional recovery and return to work. [4]

A post-stroke aphasia is an acquired language impairment that affects speaking, listening, reading, and writing.[1]

It can be divided into three categories: fluent aphasia, also called receptive aphasia, nonfluent aphasia, also called expressive aphasia, global aphasia, and "Pure" aphasia (e.g., alexia, agraphia and pure word deafness).[5]

According to the American Speech-Language-Hearing Association [6], aphasia symptoms can vary based on the location of damage in the brain. Signs and symptoms present in individuals with aphasia and vary in severity and level of disruption to communication.

- Inability to comprehend language
- Inability to pronounce, not due to muscle paralysis or weakness
- Inability to speak spontaneously
- Inability to form words
- Inability to name objects (anomia)
- Excessive creation and use of personal neologisms
- Inability to repeat a phrase
- Persistent repetition of one syllable, word, or phrase (stereotypies)
- Paraphasia (substituting letters, syllables or words)
- Agrammatism (inability to speak in a grammatically correct fashion)
- Dysprosody (alterations in inflexion, stress, and rhythm)
- Incomplete sentences
- Inability to read
- Inability to write
- Limited verbal output
- Difficulty in naming
- Speech disorder
- Inability to follow or understand simple requests
- Temporary Blindness

Aphasia improves during the first 4 weeks in one-third of patients and during the first 6 months in approximately half of them. Effective therapeutic strategies are needed to treat aphasic patients. Treatments which can benefit people with aphasia includes intensive speech and language therapy combined with medications [7]

New lines of treatment include: Stem cell transplantation, Transcranial Magnetic Stimulation, and Hyperbaric oxygen therapy (HBOT). Early and intensive speech and language therapy is the only effective treatment to date but usually is limited in duration and intensity. Therefore, improved and additional treatment strategies are required to improve recovery of language functions[8].

Hyperbaric oxygen treatment (HBOT) involves inhaling up to 100% oxygen at a pressure greater than one atmosphere (atm) in a pressurized chamber[9]. Decreased oxygenation to the damaged area including blood vessels further prevents tissue repair and the generation of new synaptic connections[9]. Consequently, increased oxygen has been considered as a potential treatment for stroke for several decades[10].

Initially, Hyperbaric oxygen therapy (HBOT) was used to treat decompression sickness in divers; however, over the years its far-reaching potential was recognized, and it has been approved for a variety of purposes including wound repair, carbon monoxide poisoning, anemia, thermal burns, delayed radiation injuries, osteomyelitis, and actinomycosis[10].

In addition to these conditions, there has been a great deal of interest in the use of HBOT for brain injury, stroke, and cerebral palsy. The use of HBOT for brain injury is based on the hypothesis that injured or inactive neurons would benefit from

increased blood flow and oxygen delivery, which would act to metabolically or electrically reactivate the cells [11].

Treatment with HBOT for these disorders uses higher pressures (over 2.0 atm). Higher pressure HBOT has been shown to increase the oxygen content of plasma and body tissues[12].

HBOT has been reported to possess strong anti-inflammatory properties and has been shown to improve immune function. There is evidence that oxidative stress can be reduced with HBOT through the up regulation of antioxidant enzymes. HBOT can also increase the function and production of mitochondria and improve neurotransmitter abnormalities. [13]

AIM OF THE WORK:

This study aim to evaluate effect of Hyperbaric Oxygen Therapy (HBOT) as a recent tool in management of aphasia/ dysphasia in order to highlight this therapeutic technique in order to generalize these results in future studies.

PATIENT AND METHODS:

Patients:

This study was applied on 30 patients with age ranging from 40 - 60 years, from January 2018 to September 2021, diagnosed with ischemic stroke, based on objective and clinical measures recruited from the outpatient Phoniatric clinic at Ain Shams University Hospitals, and Kobree el kobba military hospital.

The patients were distributed randomly into two groups. Group I, receiving only language therapy sessions. Group II, receiving both language therapy sessions and adjuvant HBO therapy.

Selection criteria:

Inclusion criteria:

- Adult (aged 40-60 years) patients were included if they had a diagnosis of ischemic stroke, according to imaging findings by brain computed tomography (CT) without evidence of hemorrhage, upon admission to the hospital.
- After complete neurological stability and improvement of health status.

Exclusion criteria:

- Patients with contraindications or risk factors for HBOT (i.e., uncontrolled high fever, emphysema with CO_2 retention, pneumothorax, or seizure disorder).
- Patient with severe cognitive impairment

Methods: All patients underwent the following steps:

All patients were subjected to the following:

1. Elementary diagnostic procedures including patient interview and careful history taking.
2. Clinical Diagnostic Aids:

a) Auditory perceptual assessment (APA)
b) General examination: Temperature, pulse, blood pressure
c) E.N.T examination: Oral cavity, pharynx, nasal cavity, ears, indirect laryngoscopy.
d) Neurological examination:

1. Cranial nerves
2. Motor system
3. Sensory system

II. Clinical Diagnostic Aids:

1. Formal testing:

a) Dysphasia test: (Modified Arabic version of the comprehensive aphasia test (CAT) (M.Y. Abou El-Ella, et al 2013)

The modified CAT consists of 34 subtests divided into three parts: The Cognitive Screen, the Language Battery and the Disability Questionnaire (DQ). The contents of the test are summarized in Table 1.

Table 1: Contents of comprehensive aphasia test

Sections	Subtests
The cognitive screen	− Line bisection − Semantic memory − Word fluency − Recognition memory − Gesture object use − Arithmetic
The language battery Language comprehension	− Spoken word comprehension − Spoken sentence comprehension − Spoken paragraph comprehension − Written word comprehension − Written sentence comprehension
Repetition	− Word repetition − Morphologically complex word repetition − Nonword repetition − Digit span − Sentence repetition
Spoken output	− Object naming − Action naming − Spoken picture description
Reading aloud	− Word reading − Morphologically complex word reading − Function word reading − Nonword reading
Writing	− Copying − Written picture naming − Writing to dictation − Written picture description
The disability questionnaire	− Disability self-rating − Intrusion − Self-image − Emotional impact

Scoring of the modified CAT:

The scoring of the modified CAT is simple. Almost all the test items are scored on a 0–2 scale, enabling the clinician to integrate more subtle responses of delay and self-correction within the score. This scoring system is supplemented by rating scales used in the spoken and written picture description subtests. The DQ is also scored using a rating scale of 0–4. T-scores are derived from the raw scores based on the standardization sample of 100 test results of aphasic participants. The overall severity of aphasic impairment is estimated by taking the mean T-score across the eight language modalities of the CAT (totals of spoken language, written language, repetition, naming, spoken picture description, reading, writing and written picture description). If scores are unavailable, the mean score on at least 4–6 of the eight modalities may yield a reliable estimate of the overall severity. The T-scores of the combined modalities are represented on a graph known as the T-score profile on which the cut-off scores are

represented. Scores below the cut-off points indicate aphasic performance.

b) Evaluation of the cognitive and perceptual abilities

III. Additional Instrumental Measures (if needed):

1. Computerized tomography (CT) of the brain

2. Electroencephalography (EEG)

3. Magnetic Resonance Imaging (MRI)

4. Additional consultation.

- After the assessment, Patients of group I received only language therapy 2 times/week each 60 minutes for 3 months.
- Patients included in group II received HBOT sessions 60 minutes/session, 2 times /week for 3 months with traditional language therapy 2 times/week each 60 minutes.
- Hyperbaric oxygen therapy (HBOT) is a treatment in which patients breathe 100% oxygen while inside a hyperbaric chamber pressurized to greater than sea level (1 atmosphere absolute [ATA])
- Patients were thoroughly examined to evaluate their fitness to undergo HBOT.
- The pre HBOT investigations include detailed clinical examination, complete ENT examination, chest x-ray, and echocardiography.
- Before each session, blood pressure and blood glucose level should be measured for each patient.
- As soon as the patient's condition allows hyperbaric oxygen therapy, we start HBOT sessions within the first month of the stroke.
- Language sessions started 3 months after the stroke in both groups.
- After 3 months the patients were re-evaluated and the results obtained from the work were tabulated and statistically analyzed.

Statistical Analysis:

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (SPSS 20). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

Descriptive statistics:

1. Mean and Standard deviation (± SD) for numerical data.
2. Frequency and percentage of non-numerical data.

p-value was considered significant as the following:

$P > 0.05$ = non-significant (NS)

$P < 0.05$ = significant (S)

RESULTS:

This study included 30 patients. The patients were distributed randomly into two matched groups. Group I, receiving only language therapy sessions. Group II, receiving both language therapy sessions and adjuvant HBO therapy.

1- As shown in table (2): demographic results of both groups. Data showed that the mean age of group I was 47.13 ± 4.72, the mean age of group II was 47.60 ± 6.97 SD, Sex results it was found 53.3% Females, 46.7% Male in group I, and there was 53.3% Females, 46.7% Male in group II, Handiness results it was found 6.7% Left, 93.3% Right in group I, and there was 6.7% Left, 93.3% Right in group II,

Table (2): Comparison between Group I (no. =15) and Group II (no. =15) regarding Age, Sex, Marital status, Handiness, Illiteracy.

		Group I	**Group II**	**Test of sig.**	**p**
		No.= 15	**No.= 15**		
Age	Mean ± SD	47.13 ± 4.72	47.60 ± 6.97	t= 0.215	0.831
	Range	39.0 – 55.0	33.0 – 56.0		
Sex	Female	8 (53.3%)	8 (53.3%)	χ^2=0.000	1.000
	Male	7 (46.7%)	7 (46.7%)		
Handiness	Left	1 (6.7%)	1 (6.7%)	χ^2=0.000	^{FE}p=1.000
	Right	14 (93.3%)	14 (93.3%)		
Illiteracy	Educated	13 (86.7%)	10 (66.7%)	χ^2=1.677	^{FE}p=0.390
	Illiterate	2 (13.3%)	5 (33.3%)		

χ^2: Chi square test, MC: Monte Carlo, FE: Fisher Exact t: Student t-test
U :Mann Whitney test p: p value for comparing between the studied groups
P-value >0.05: Nonsignificant (NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant (HS)

Table (3): shows the means and standard deviations among group I. There was statistically significant difference before and after language therapy regards comprehension score, expression score, reading score and writing score.

Table (3): Dysphasia test before and after language therapy in group I.

Group I		**Before**	**After**	**Z**	**P-value**	**Sig.**
		No.= 15	**No.= 15**			
Comprehension score 10	Mean ± SD	6.33 ± 0.98	8.40 ± 2.23	2.362*	0.018*	S
	Range	5.0 – 8.0	5.0 – 12.0			
Expression score 10	Mean ± SD	4.67 ± 2.06	8.40 ± 2.44	2.962*	0.003*	S
	Range	1.0 – 8.0	4.0 – 12.0			
Reading score 5	Mean ± SD	3.60 ± 0.83	4.53 ± 1.92	1.932	0.053	NS
	Range	3.0 – 5.0	2.0 – 8.0			
Writing score 5	Mean ± SD	3.73 ± 1.28	4.53 ± 2.72	0.915	0.360	NS
	Range	2.0 – 5.0	1.0 – 10.0			

Z: Wilxcon Signed Rank **test** p: p value for comparing between before and after
*: Statistically significant at p ≤0.05 P-value >0.05: Non significant (NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant (HS) .

Table (4): shows the means and standard deviations among group II. There was statistically significant difference before and after HBOT and language therapy regards comprehension score, expression score, reading score and writing score.

Table (4): Dysphasia test before and after Hyperbaric Oxygen Therapy (HBO) in group II.

Group II		Before	After	Z	P-value	Sig.
		No.= 15	No.= 15			
Comprehension score 10	Mean ± SD	6.40 ± 1.24	10.93 ± 2.15	3.313*	0.001*	S
	Range	5.0 – 9.0	8.0 – 14.0			
Expression score 10	Mean ± SD	5.40 ± 2.50	6.40 ± 1.84	0.886	0.376	NS
	Range	1.0 – 9.0	4.0 – 10.0			
Reading score 5	Mean ± SD	4.20 ± 0.77	6.47 ± 2.64	2.453*	0.014*	S
	Range	3.0 – 5.0	2.0 – 9.0			
Writing score 5	Mean ± SD	3.80 ±1.08	6.47 ± 1.81	3.090*	0.002*	S
	Range	2.0 - 5.0	4.0 – 9.0			

Z: Wilxcon Signed Rank test p: p value for comparing between before and after
*: Statistically significant at p ≤0.05 P-value >0.05: Non significant (NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant (HS)

Table (5): shows the means and standard deviations among two groups and shows that was non statistically significant difference found between two groups regarding Dysphasia test Before Regards comprehension score, expression score, reading score and writing score.

Table (5): Comparison between Groups I (no. =15) and Group II (no. =15) regarding Dysphasia test before therapy

Dysphasia test Before		Group I	Group II	U•	P-value	Sig.
		No.= 15	No.= 15			
Comprehension score 10	Mean ± SD	6.33 ± 0.98	6.40 ± 1.24	112.0	0.983	NS
	Range	5.0 – 8.0	5.0 – 9.0			
Expression score 10	Mean ± SD	4.67 ± 2.06	5.40 ± 2.50	94.0	0.439	NS
	Range	1.0 – 8.0	1.0 – 9.0			
Reading score 5	Mean ± SD	3.60 ± 0.83	4.20 ± 0.77	67.50*	0.047*	S
	Range	3.0 – 5.0	3.0 – 5.0			
Writing score 5	Mean ± SD	3.73 ± 1.28	3.80 ±1.08	111.0	0.948	NS
	Range	2.0 – 5.0	2.0 - 5.0			

P-value >0.05: Non significant (NS); P-value <0.05: Significant(S); P-value < 0.01: highly significant (HS) U: Mann Whitney test p: p value for comparing between the studied groups *: Statistically significant at p ≤0.05

Table (6): shows the means and standard deviations among two groups and shows that was highly statistically significant difference found between two groups regarding Dysphasia test After Regards comprehension score, expression score, reading score and writing score

Table (6): Comparison between Group I (no. =15) and Group II (no. =15) regarding Dysphasia test after therapy

Dysphasia test After		**Group I**	**Group II**	**U**	**P-value**	**Sig.**
		No.= 15	**No.= 15**			
Comprehension score 10	Mean ± SD	8.40 ± 2.23	10.93 ± 2.15	50.50*	0.010*	S
	Range	5.0 – 12.0	8.0 – 14.0			
Expression score 10	Mean ± SD	8.40 ± 2.44	6.40 ± 1.84	59.50*	0.025*	S
	Range	4.0 – 12.0	4.0 – 10.0			
Reading score 5	Mean ± SD	4.53 ± 1.92	6.47 ± 2.64	62.50*	0.036*	S
	Range	2.0 – 8.0	2.0 – 9.0			
Writing score 5	Mean ± SD	4.53 ± 2.72	6.47 ± 1.81	63.0*	0.039*	S
	Range	1.0 – 10.0	4.0 – 9.0			

P-value >0.05: Non significant (NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant (HS) U: Mann Whitney test p: p value for comparing between the studied groups
*: Statistically significant at p ≤0.05

DISCUSSION:

Stroke is the second-most cause of mortality and the third leading cause for disability, worldwide. Whether stroke is ischemic or hemorrhagic, the injured brain region correlates with its related loss of function which may be visual, motor, sensory or cognitive impairments (Katan and Luft.2018).

It has been estimated that about 21–38% of stroke patients develop aphasia. It has been reported that 20–40% of aphasias are of the global type, whereas the classic aphasia types, such as Broca's or Wernicke's aphasia, are found in a quarter of patients, and 10–15% of patients are unclassifiable according to traditional typologies during the acute stage of stroke (Khedr, et al .2020).

Aphasia improves during the first 4 weeks in one-third of patients and during the first 6 months in approximately half of them. Effective therapeutic strategies are needed to treat aphasic patients. Treatments which can benefit people with aphasia include: intensive speech and language therapy combined with medications (Fridriksson and Hillis.2021).

New lines of treatment include: Stem cell transplantation, Transcranial Magnetic Stimulation, and Hyperbaric oxygen therapy (HBOT). Early and intensive speech and language therapy is the only effective treatment to date but usually is limited in duration and intensity. Therefore, improved and additional treatment strategies are required to improve recovery of language functions (McDevitt et al., 2021).

As compared to treatment with HBOT for many classical indications, HBOT used at lower pressures (e.g. 1.3 to 1.5 atm and oxygen at 24 to 100%) has started to be investigated to treat certain neurological disorders, some of which are considered to have few efficacious treatments. For example, recent studies have investigated lower pressure HBOT for traumatic brain injury (TBI) in both animal models and humans (Brugniaux et al., 2018).

This was a prospective study that was carried out on thirty (30) patients in the phoniatrics unit, Ain shams university hospital and Kobree El kobba military hospital. The patients were distributed randomly into two groups. Group I, receiving only language therapy sessions. Group II, receiving both language therapy sessions and adjuvant HBO therapy.

The current study revealed statistically significant difference between two groups (Language therapy only versus language therapy and Hyperbaric Oxygen Therapy) on applying (Modified Arabic version of the comprehensive aphasia test (CAT) (M.Y.Abou El-Ella, et al 2013) Also, there was statistically significant difference found between before and after treatment regarding comprehension score 10, expression score 10, reading score 5 and writing score 5.

This is the first study to focus on the effect of Hyperbaric Oxygen in improving language functions of aphasic patients. Whereas the previous studies focused on the cognitive functions. In accordance with the current study, Li et al (2015) study concluded that HBO therapy at the pressure level of 0.175 MPa is more appropriate for treatment of aphasia after craniocerebral injury to ensure the safety, efficacy and patient compliance.

In a previous study, there were significant improvements in the neurological functions, tested by the National Institutes of Health stroke scale (NIHSS), activities of daily living (ADL) and quality of life (Murie-Fernández et al., 2020).

Another prospective study reported significant improvements in the memory domain after HBOT. Yet, the other cognitive domains were not explored and the stroke nature was not evaluated as a possible confounder (Hadanny, Amir et al., 2020).

Churchill published a prospective study (Churchill et al., 2013) that included 22 patients at least one year after stroke. HBOT induced improvement in symptoms reports (51% memory, 51% attention/concentration, 48% balance/coordination, 45% endurance, 20% sleep).

Another small prospective study on seven patients showed verbal memory and executive function improvements in addition to sleep and quality of life changes (E. R. Rosario et al., 2018).

Efrati et al (2013), described the beneficial effects of HBOT applied in the neurological rehabilitation of 74 patients after stroke. They had 40 HBOT sessions at a pressure of 2 ATM for 2 months. The hyperbaric treatment improved the patients' neurological functions, including speech, more than the standard treatment applied to other patients.

Hadanny et al (2018), described the use of HBOT in a distant time after brain damage as it was conducted on patients who had suffered brain injury 3 months to 33 years before. A team of scientists observed significant improvement in cognitive functions in correlation with an increase in the neurological activity in individual parts of the brain. After the HBOT, the patients' memory and attention usually improved.

Conclusions and Recommendations

Hyperbaric oxygen therapy is effective in treatment of aphasia after stroke as an adjuvant therapy with language therapy.

It is recommended to do this study on large number of patients to support the results and to widen the use of hyperbaric oxygen in aphasia treatment.

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تأثير العلاج بالأكسجين عالي الضغط في علاج المرضى الذين يعانون من فقدان القدرة على الكلام (العي)

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المقدمة:

السكتة الدماغية هي السبب الرئيسي للوفاة والعجز.وهو أكثر شيوعا عند الأفراد الأكبر سنا ، ولكنه يحدث ايضا عند البالغين والأطفال الصغار.

يعاني حوالي ثلثي المصابين بالسكتات الدماغية من اضطراب التواصل الذي يؤثر بشكل كبير على الشفاء الوظيفي والعودة إلى العمل.

تتحسن القدرة على الكلام خلال الأسابيع الأربعة الأولى في ثلث المرضى وخلال الأشهر الستة الأولى في نصفهم تقريبًا.

وتشمل طرق العلاج الجديدة: زرع الخلايا الجذعية ، التحفيز المغناطيسي عبر الجمجمة ، والعلاج بالأكسجين تحت الضغط العالي .

ويتضمن العلاج بالأكسجين عالي الضغط استنشاق ما يصل إلى 100٪ من الأكسجين عند ضغط أكبر من جو في غرفة مضغوطة.

وبما أن نقص الأوكسجين في المنطقة المتضررة بما في ذلك الأوعية الدموية يمنع كذلك إصلاح الأنسجة وتوليد وصلات متشابكة جديدة ، فإنه تم اعتبار زيادة الأكسجين كعلاج محتمل للسكتة الدماغية لعدة عقود.

هدف الدراسة:

الهدف من هذا العمل هو تقييم تأثير العلاج بالأكسجين عالي الضغط كأداة حديثة في إدارة فقدان القدرة على الكلام / عسر الكلام من أجل تسليط الضوء على هذه التقنية العلاجية .

المرضى:

تشمل هذه الدراسة ثلاثون مريضاً يعانون من سكتة دماغية وفقد القدرة على الكلام ممن يترددون على عيادة التخاطب بمستشفيات جامعة عين شمس ,والمجمع الطبي بكوبري القبة للقوات المسلحة .مقسمون عشوائياً الى مجموعة I (15 مريض) ويتم بها استخدام العلاج بتدريبات للتحفيز اللغوي فقط ,ومجموعة II (15 مريض) وخضعت هذه المجموعة الى العلاج بالأكسجين عالي الضغط مع تدريبات للتحفيز اللغوي .

النتائج:

مقارنة نتائج العلاج بجلسات اللغة, مع نتائج العلاج بالأكسجين عالي الضغط مع جلسات اللغة, وجد فروق ذات دلالة احصائية عالية بين المجموعتين فيما يتعلق باختبار العي الشامل المعرب بخصوص درجة الفهم , ودرجة التعبير , ودرجة القراءة , ودرجة الكتابة .

الخلاصة:

العلاج بالأكسجين عالي الضغط فعال في علاج فقدان القدرة على الكلام بعد السكتة الدماغية كعلاج مساعد مع التحفيز اللغوي.