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Cognitive Functions in Patients with Idiopathic Normal Pressure Hydrocephalus Before and After Ventriculoperitoneal Shunt

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Abstract: Background: Clinical manifestations of idiopathic normal pressure hydrocephalus [iNPH] involve dementia, urinary incontinence and gait disturbance. Idiopathic normal pressure hydrocephalus treatment for short- and long-term improvement and maintenance of gait and also cognitive function is essential for reducing the caregiving burden on families and society. Methods: this study was done on 41participants with a diagnosis of iNPH, subjected to detailed medical and neurological history taking and neuropsychological assessment for cognitive functions before and after ventriculoperitoneal shunt operation. Results: After CSF (cerebro-spinal fluid) shunting, around 80.5% of cases with idiopathic normal pressure hydrocephalus demonstrated enhanced and sustained cognitive function for at least 1 year post-operatively and our study revealed that younger age and less severe idiopathic normal pressure hydrocephalus led to a good long-term prognosis of cognitive function. Conclusions: Individuals with idiopathic normal pressure hydrocephalus experienced improved cognitive function 3-12 months after CSF shunt operation, with greater improvement seen in younger patients with milder illness. Therefore, early identification and appropriate treatment are crucial for long-term recovery and preservation of cognitive function in idiopathic normal pressure hydrocephalus. Early diagnosis of iNPH followed by CSF Shunt treatment can improve cognitive functions. Long-term evaluations of cognitive functions after V-P (ventriculo peritoneal) shunt operation are recommended.

Keywords: INPH, CSF, INPHGS, MRI, V-P shunt, MMSE, MOCA, AD

1. Introduction

INPH is manifested clinically by disturbances in gait, dementia, and urinary incontinence [1, 2].

Although INPH is uncommon, new population-based epidemiological studies have demonstrated that iNPH impacts two to three percent of the elderly [3].

The advancement of gait and cognitive impairment results in the need for home and community care.

Idiopathic normal pressure hydrocephalus treatment for long and short-term enhancement also maintenance of gait and cognitive function is essential for reducing the burden of caregiving on families and society.

In 80% of cases, gait function was determined to have improved three years after surgery; [4, 5].

However, a few research studies have provided information about the long-term prognosis of cognitive function in iNPH people with the majority of studies having a one-year monitoring [6].

As a result, the long-term cognitive prognosis, the course of idiopathic normal pressure hydrocephalus after two years post-operatively and their associated factors are unknown.

The purpose of the research was aimed to develop a comprehensive profile of cognitive malfunction in idiopathic

normal pressure hydrocephalus in addition to assess the impact of cerebrospinal fluid [CSF] shunt operation on cognitive dysfunction.

2. Methods

The Ethical Committee of the Faculty of Medicine at Zagazig University Hospitals approved all procedures in this investigation. After a comprehensive explanation of the study procedure, written informed consent was obtained from every individual participating.

Obtaining a dependable preoperative iNPH diagnosis cannot be determined based on any accepted criteria. [7]

To rule out co morbidity and the potential for incorrect diagnosis, we recruited only patients who revealed significant improvement following shunt surgery, the classic diagnostic criterion for iNPH. [8]

According to guidelines from the Japanese Society of Normal Pressure Hydrocephalus, those who exhibit ventricular enlargement with narrowing of the high convexity/midline subarachnoid spaces on MRI as well as at least one of the following signs [gait disturbance, cognitive dysfunction, or urinary incontinence] should be examined for further evaluation. [9]

Individuals who were thought to have multiple sclerosis underwent a battery of diagnostic tests including a neurological exam, neuropsychological assessments, magnetic resonance imaging of the brain, laboratory investigations, single photon emission computed tomography, as well as a lumbar CSF puncture. The other people received shunt surgery despite the results of their CSF tap tests. [9]

The idiopathic normal pressure hydrocephalus Grading Scale [iNPHGS] was utilized to assess clinical symptoms prior to and following CSF shunt surgery. [10]

On this scale, each of the three symptoms receives a score among one andfour besides the scale for the overall score goes from zero [normal] to twelve [extreme]. Significant improvement was defined as a reduction of 6.1 points on the total idiopathic normal pressure hydrocephalus score after surgery relative to the score at baseline.

There were 41 persons admitted to the Neurology and Neurosurgery Units at with iNPH during May 2021 and March 2023. Participants were excluded if they did not finish the neuropsychological tests because of clinical factors like refusal, delirium, or extreme disregard.

The following neuropsychological assessments were administered to assess different cognitive domains: MMSE [Mini mental state Examination] for general mental performance [Mori E1985] [11] and MONTREAL COGNITIVE ASSESSMENT [MOCA].

The montreal cognitive assessment evaluates multiple cognitive domains. These abilities include Visuospatial /Executive, Naming, Attention, Memory, Abstraction, Delayed Recall, Language, also Orientation [to time and place]. There are several aspects that are common to other tests of cognitive function or are at least conceptually similar. Two tasks, the clock drawing test and the trail creation test, are used to evaluate a candidate's visuospatial abilities, which are helpful in assessing driving fitness. A sustained attention test [target detection by tapping], a serial subtraction problem, and digits forward and backward are used to evaluate the participant's ability to focus, remember and understand information. [12]

Statistical analysis: Using IBM Corp., all data were captured, tabulated, and statistically analyzed. Published in 2015. The 23.0 version of IBM SPSS Statistics for Windows. IBM Corporation's headquarters are located in Armonk, New York. Quantitative data were presented as the mean± SD, while qualitative data were displayed as number and %. To compare two classes of normally distributed variables, a t test was utilized. The Paired t Test was used to compare paired variables with non-normal distribution. When applicable, the percentage of categorical parameters was assessed using the Chi-square or Fisher Exact test. All exams were double-sided. P-values less than 0.05 were statistically significant, whereas p-values ≥ 0.05 were statistically insignificant.

3. Results

This study was done on 41 patients 25 [61.0%] males and 16 [39.0%] females with mean age 64.4± 7.4.

All cases were subjected to detailed medical and neurological history taking and neuropsychological assessment for cognitive functions before and after Ventriculoperitoneal shunt operation 33 cases [80.5%] improved after surgery14 [42.4%] females and 19 [57.6%] males.

MMSE improved from mean [17.1±2.9] to [22±1.7] in improved group and M0CA improved from [18.9±3.7] to [23.5±2.03].

In 33 cases 80.5% of the patients with iNPH showed improved and maintained cognitive function after CSF shunting for at least 1 year post-operatively.

Table 1. *Basic characters of studied patients [n=41].*

Variables	
Sex	
Females	16 [39.0%]
Males	25 [61.0%]
Age per years	
Mean± SD	64.4± 7.4
range	48-79
Education	
Mean± SD	12.2± 2.7
range	9-16

Table 2. *Prognosis of iNPH after shunt operation.*

Outcome	Frequency	Percent
Improve	33	80.5
Decline	8	19.5
Total	41	100.0

iNPH: idiopathic normal pressure hydrocephalus

Table 3. *Comparison between improved and decline MMSE patients regard their age and sex.*

Variables	Improved patients n.33	Decline patients n.8	t	p
Age per years (Mean± SD)	64.9±7.7	62.4±6.2	0.85	0.401
Sex				
Females	14 [42.4%]	2 [25.0%]	f	0.45
males	19 [57.6%]	6 [75.0%]		

t: Student t test, p>0.05: insignificant, F: Fisher exact test
MMSE: mini mental state examination

Table 4. *Comparison mean of cognitive parameters in improved and decline MMSE after shunt operation.*

Variables	All patients n.41	Improved patients n.33	Decline patients n.8	t	p
visuospatial	2.9±0.82	2.9±0.82	2.9±0.83	.197	.845
naming	2.1±0.39	2.±0.44	2±0	.961	.342
attention	3.4±1.02	3.5±1.1	3.3±0.9	.502	.618
language	2.07±0.26	2.1±0.29	2±0	.872	.388
abstraction	1.02±0.16	1.03±0.17	1±0	.488	.629
Delayed recall	3.02±0.88	3.03±0.95	3±0.53	.086	.932
Orientation	3.3±0.93	3.4±0.99	3±0.53	1.07	.29
Patients cognitive score	17.9±3.7	18.1±3.9	17.1±2.4	0.67	0.51

Data express as; mean ±SD t: Student t test
MMSE: mini mental state examination

Table 5. *Comparison mean of MMSE, MOCA, in improved and decline MMSE after shunt operation.*

	All patients n.41	Improved patients n.33	Decline patients n.8	t	p
MMSE before	18.1±3.5	17.1±2.9	22.4±1.6	6.91	.0001
MMSE after	21.6±1.8	22±1.7	20.3±1.03	2.6	0.02
Paired t	5.9	9.9	4.4		
P -value	0.0001	0.0001	0.003		
MOCA before	18.9±3.6	18.9±3.7	18.87±3.2	.026	.98
MOCA after	23.5±2.1	23.5±2.03	23.5±2.7	.058	0.96
Paired t	6.7	6.2	2.7		
P -value	0.0001	0.0001	0.03		

MMSE: mini mental state examination
MOCA: Montreal cognitive assessment scale

Table 6. *Comparison cognitive parameters throughout study phases before and after surgery.*

Variables	Study phase			Paired t	P
	Before	after	% improvement		
Visuospatial (mean ± SD)	2.9±0.82	4.05±0.83	39.6%	5.84	.0001
Naming (mean ± SD)	2.1±0.39	3±0	42.8%	14.1	.0001
Attention (mean ± SD)	3.4±1.02	4.7±1.07	37.9%	5.17	.0001
Language (mean ± SD)	2.07±0.26	2.8±0.44	36.2%	9.9	.0001
Abstraction (mean ± SD)	1.02±0.16	2±0.44	95%	13.2	.0001
Delayed recall (mean ± SD)	3.02±0.88	3.9±0.53	27.2%	5.3	.0001
Orientation (mean ± SD)	3.3±0.93	3.4±0.84	3.6%	0.606	0.55
Patients cognitive score (mean ± SD)	17.9±3.7	23.9±2.7	33.3%	8.05	0.0001

Paired t, no significant [p>0.05], highly significant [p<0.001]
% of improvement = [after value – before value] / before value] * 100

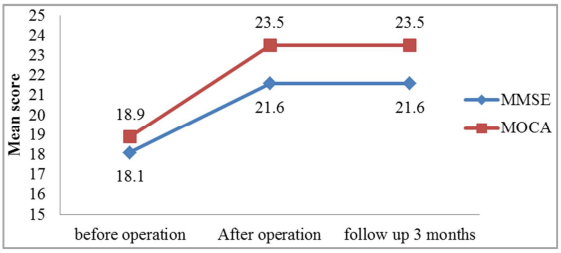

Figure 1. *Line mean score of MMSE, MOCA, throughout study phases.*

MMSE: mini mental state examination
MOCA: Montreal cognitive assessment scale

4. Discussion

This research was conducted with cognitive impairment as a primary focus because it is a prominent sign of idiopathic normal pressure hydrocephalus [iNPH].

In our study, 80.5% of patients with idiopathic normal pressure hydrocephalus who underwent CSF shunting for at least one year post-operatively demonstrated enhanced and sustained cognitive function.

Prior research indicated that the MMSE scores of cases with iNPH enhanced by approximately one point over the

course of one year; however, it persisted unclear whether this improvement was sustained. [13-14].

Despite investigating a limited number of individuals, some studies have found that shunting has no long-term effect on cognitive function [4].

In our investigation, we discovered that the average MMSE score improved by 1.8 points one year after surgery.

In comparison to Andrén and colleagues [15] found that At 13 months following diagnosis, patients with untreated iNPH exhibited a drop of 3 points in MMSE score. People with idiopathic normal pressure hydrocephalus who undergo CSF shunting report considerable improvements in their cognitive abilities, with many reporting improvements lasting for over two years.

Although long-term cognitive prognosis fluctuates greatly across people, age [p = 0.401] andiNPH Grading Scale [p = 0.0001] are predictive variables. The accuracy of predictions will be a topic for future research.

This research involved a substantial number of elderly individuals, with mean ages of 64.9 ±7.7 and 62.4 ± 6.2 years for the maintenance/improvement and decline categories, correspondingly.

This was matched with Leal, [16], Libard and their colleagues., [17] reported that although iNPH's cause is unknown, advanced age is thought to be a major contributor to developing the condition. Patients with iNPH have a higher than average risk of developing other neurological illnesses. Therefore, older age may be linked to a worse prognosis of cognitive performance in the long run due to the increased likelihood of co morbidities.

Postoperative improvement of iNPH symptoms may be influenced by coexisting Alzheimer disease [AD], however this has not been investigated in the long term [18].

This study demonstrates that better long-term cognitive outcomes are associated with both younger age and milder iNPH. This emphasizes the need of early treatment as well as diagnosis in maintaining cognitive function throughout time.

Furthermore, Andrén and colleagues. [15] informed that the progression of iNPH symptoms is irreversible in addition postponing operation may exacerbate symptoms. In order to improve the long-term cognitive prognosis of idiopathic normal pressure hydrocephalus individuals, this demonstrates the importance of early identification and treatment.

As a result, these individuals may experience difficulties with psychomotor speed, attention, working memory, focus, spatial and creative ability, mental flexibility andexecutive functions [19].

However, there are evidence for improvement in global cognitive function, psychomotor speed, learning as well as verbal memory was discovered in a meta-analysis evaluating the impact of shunt operation on neuropsychological performance that was published. [20]

In our study we found improvement on cognitive parameters throughout study phases before and after surgery which involve [Visuospatial, Naming, Language, Abstraction, Attention, Delayed recall] but no improvement on Orientation.

We use Receive operator curve to detect cognitive score as predictor of improvement after shunt operation and it show that cognitive score had no effect on prognosis [AUC=0.595].

Also use Receive operator curve to detect age as predictor of improvement after shunt operation and found that age had no effect on prognosis [AUC=0.617] but when we use Receive operator curve to detect pre -operative MMSE as predictor of improvement after shunt operation found that MMSE had relation with good prognosis AUC=0.93].

This study avoids several limitations which were on much previous study, such as, first the duration of this study which was short in study. [21]

Second, the MMSE, a screening test that can evaluate global cognitive function, has limited utility when used alone to evaluate cognitive purpose in idiopathic normal pressure hydrocephalus. In the present research, it is believed that a cognitive function test appropriate for moderate cognitive impairment, for instance the Montreal Cognitive Assessment, has greater accuracy [22].

Multiple evaluations should be used to evaluate a vast array of cognitive abilities. Even though we incorporated multiple potentially pertinent predictors, we did not include all of them. For instance, research in the future must investigate incorporating idiopathic normal pressure hydrocephalus -specific neuroimaging variables [for example the Evans index] and factors related to AD and atherosclerosis.

Pathological investigation may be necessary for the diagnosis of AD and other co morbidities; however, the ethical implications of this were not always clear. Persons with idiopathic normal pressure hydrocephalus showed substantially enhanced cognitive function three to twelve months following CSF shunt operation. Younger individuals with less severe illness showed more cognitive improvement as well as maintenance. Therefore, in situations of idiopathic normal pressure hydrocephalus, long-term recovery and preservation of cognitive function necessitates early identification as well as suitable treatment.

5. Conclusion

Individuals with idiopathic normal pressure hydrocephalus experienced improved cognitive function 3-12 months after CSF shunt operation, with greater improvement seen in younger patients with milder illness. Therefore, early identification and appropriate treatment are crucial for long-term recovery and preservation of cognitive function in idiopathic normal pressure hydrocephalus. Early diagnosis of iNPH followed by CSF Shunt treatment can improve cognitive functions. Long-term evaluations of cognitive functions after V-P (ventriculo peritoneal) shunt operation are recommended.

Ethics Approval and Consent Participate

A written informed consent was obtained from every patient or his/her relative to be included in the study. This

study was approved by the institute research board of Faculty Of Medicine, Zagazig University [IRB#:10284-1-4-2023].

Competing Interests

The authors declare that they have no competing interests.

Disclosures

The manuscript has been read and approved by all the authors.

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