Article published online: 2024-03-26

Original Article

Morphometric Changes in Ventricular Indices in Chronic Alcoholic and Nonalcoholic Patients in Mangalore: A Prospective Case-Control Study

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J Health Allied Sci[NU]

Abstract

Background Alcohol intake is increasing daily, affecting and damaging the brain in various ways. In the brain, it causes various degenerative changes, such as dilatations of the ventricles and atrophic changes, primarily seen in chronic alcoholic patients. The aim of the study was to evaluate ventricular indices in chronic alcoholic and nonalcoholic patients using computed tomography (CT).

Methods In this prospective case-control study, patients who had undergone non-contrast CT of the brain between the age of 30 and 60 years were grouped into chronic alcoholic and nonalcoholic patients. The patient's age was further grouped into 30 to 40, 41 to 50, and 51 to 60 years. This current study includes 86 male patients (43 chronic alcoholic patients and 43 nonalcoholic patients). Statistical analysis was done using SPSS software version 23. A *p*-value less than 0.05 was considered statistically significant.

Result A statistically significant difference was found in all ventricular indices between the chronic alcoholic and nonalcoholic patients, and it also inferred that ventricular index values were higher in chronic alcoholic patients than in nonalcoholic patients. A statistically significant difference was also found in all ventricular indices when compared between patients in each age group.

Conclusion In this study, ventricular dilatation was seen in chronic alcoholic patients, leading to brain atrophy. There was also evidence of a positive correlation between age and ventricular indices.

Keywords
- computed tomography
- bifrontal index
- bicaudate index
- ventricular index
- Evans index

Introduction

Alcohol intake is increasing day by day all over the world. Acute alcoholics are those who consume less alcohol and are not entirely dependent on it, whereas chronic alcoholics are those who regularly consume large amounts of alcohol, and their bodies get used to it.[1] It is seen that chronic alcoholics are more prone to liver and brain damage.[2] Alcohol and its constituents have a very harmful effect on brain tissues.[3] Alcohol consumption is increasing because of its pharmacological effects on the central nervous system (CNS), and when the person becomes completely dependent, the intake of alcohol increases to keep away the withdrawal symptoms.[4] U.S. federal dietary guidelines still allow men an alcohol intake of about 24.5

DOI https://doi.org/10.1055/s-0044-1782640.
ISSN 2582-4287.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

units a week even though alcohol consumption increases the risk of cancer. Minimal alcohol consumers (12.5 g/d or 8 units/wk) are also more likely to develop oropharyngeal, esophageal, and breast cancer, whereas chronic alcoholics are more likely to develop alcoholic dementia and Korsakoff's syndrome.[5]

The most prevalent anomaly seen in various neurologic and psychiatric illnesses, in both children and adults, is an enlargement of the ventricles.[1,4] There is evidence that drinking alcohol has some morphological changes in the brain.[6,7] The brain's ventricles are a series of interconnecting spaces filled with cerebrospinal fluid (CSF). It was created from the neural tube's core lumen in the embryo. The cerebral hemispheres' ventricular system is made up of two lateral ventricles that are joined to the third ventricle via the interventricular foramen of Monro. The cerebral aqueduct of Sylvius connects the third ventricle with the fourth ventricle.[8]

The introduction of computed tomography (CT) marked substantial advancements in quantifying the extent of brain atrophy by assessing the enlargement of ventricles and regional cortical sulci.[3] Older radiographic techniques, such as gas or contrast encephalography, were highly intrusive and generated artifacts in the lateral ventricles when used to assess the ventricles. With CT and magnetic resonance imaging (MRI), which are noninvasive and free of artifacts, measuring ventricular diameters has become simpler. As newer imaging techniques like MRI have evolved, CT remains the most widely available and relatively affordable tool for assessing brain ventricles.[1,9] Recently, CT has been used to evaluate the enlarged sulci and larger ventricles in chronic alcoholics.[2,10]

Various indices can describe the ventricular system based on linear measures, including the Evans index, the bicaudate index, the bifrontal index, and the ventricular index.[1,4] Few studies proved that abstinence from alcohol could help recover from the increased ventricular volume, although some are irreversible.[11] The current study evaluates the changes in ventricular indices in chronic alcoholic and nonalcoholic individuals by using CT.

Methods

Ethical approval was taken to conduct the present study from the Institutional Ethics Committee (EC/NEW/INST/2020/834). The study included age-matched male patients within the age group of 30 to 60 years recommended for noncontrast CT of the brain. Patients with hypertension or diabetes mellitus, a history of using any other drugs or head injuries, and patients with brain tumors or infectious diseases were excluded. A total of 86 patients, comprising 43 chronic alcoholic and 43 were nonalcoholic patients, met the inclusion criteria and were included in the study. Both chronic alcoholic and nonalcoholic patients were further categorized into the following age groups: 30 to 40 years, 41 to 50 years, and 51 to 60 years.

The patients' medical history was obtained, and the patients were asked about their drinking history and the presence of any withdrawal symptoms like shakiness. The patient was explained the details of the procedure, and informed consent was taken. They were asked to remove all metallic objects from the area of interest and then positioned for the brain CT. The scan was performed using a 128-slice GE Revolution EVO scanner. The routine CT brain protocol was used. The acquired axial images were used to calculate ventricular indices such as the bifrontal index, bicaudate index, ventricular index, and Evans' index. The ventricular indices were calculated as follows.

The bifrontal index was calculated by dividing the maximum width of the anterior horns of the lateral ventricle (a) and the inner skull width at the same level of a (a_1; ►**Fig. 1A**).

The bicaudate index was calculated by dividing the minimum width of the lateral ventricle (b) and the inner skull width at the same level of b (b_1; ►**Fig. 1B**).

Th ventricular index was calculated by dividing the minimum width of the lateral ventricle (b) and the maximum width of the anterior horns of the lateral ventricle (a; ►**Fig. 1C**).

The Evans index was calculated by dividing the maximum width of the anterior horns of the lateral ventricle (a) and the maximum width of the inner skull diameter, which was taken from another slice (c; ►**Fig. 2**).

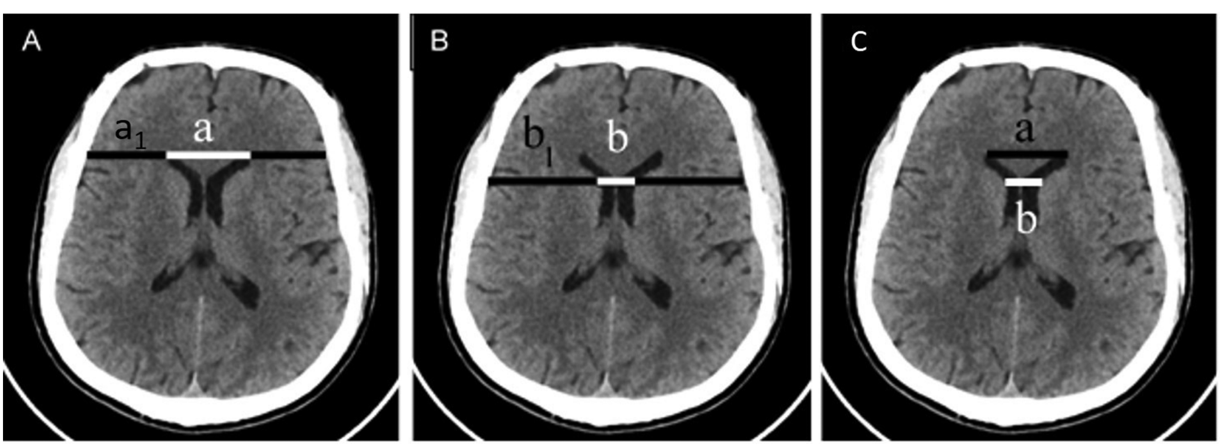

Fig. 1 (A) Bifrontal index. (B) Bicaudate index. (C) Ventricular index.

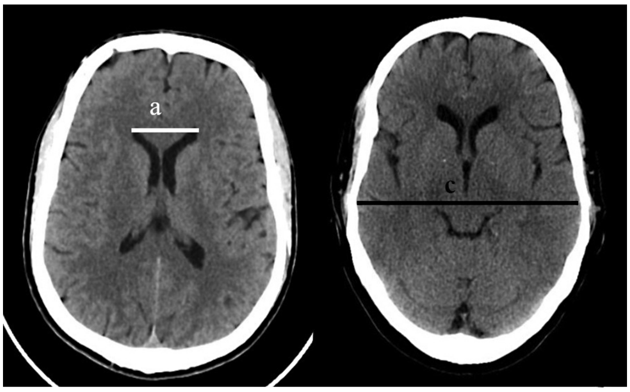

Fig. 2 Evans index.

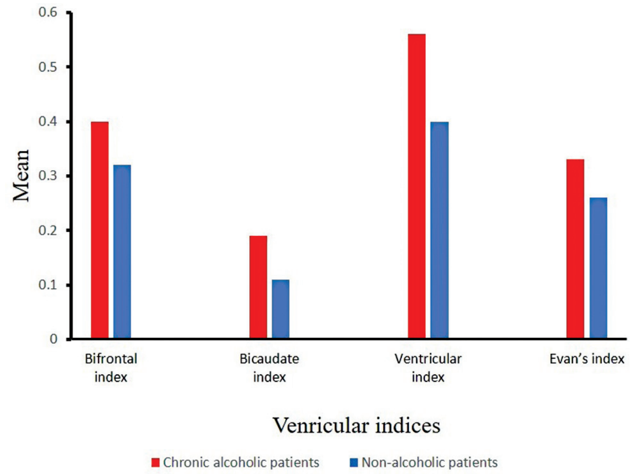

Fig. 3 Bar diagram showing the difference in the ventricular indices for chronic alcoholic and nonalcoholic patients.

Results

The patients considered in this study met all the inclusion and exclusion criteria. The sample size included 43 chronic alcoholic patients and 43 nonalcoholic patients. The study was performed over a period of 12 months from April 2022 to March 2023. The chronic alcoholic and nonalcoholic patients were compared using an independent sample *t*-test. One-way analysis of variance (ANOVA) was used to compare each age group in individual ventricular indices, with a *p*-value less than 0.05 considered statistically significant. The Pearson correlation coefficient test was also used to find the relation between each ventricular index and the age of the patients. The bifrontal index was found to have a mean of 0.36 ± 0.04 for the total sample, and the mean values for the bicaudate index, ventricular index, and Evans index were 0.15 ± 0.04, 0.48 ± 0.09, and 0.29 ± 0.04, respectively.

All four ventricular indices were compared between chronic alcoholic and nonalcoholic patients using an independent sample *t*-test. In the bifrontal index, the mean value for chronic alcoholic patients was 0.40 ± 0.02 and that for non-alcoholic patients was 0.32 ± 0.02. The bicaudate index noted for chronic alcoholic and nonalcoholic patients was 0.19 ± 0.02 and 0.11 ± 0.02, respectively. In the ventricular index, the mean value for chronic alcoholic patients was 0.56 ± 0.04 and that for nonalcoholic patients was 0.40 ± 0.05. The mean values for chronic alcoholic and non-alcoholic patients in the Evans index were 0.33 ± 0.02 and 0.26 ± 0.02, respectively. There was a statistically significant difference ($p < 0.05$) in all the ventricular indices of chronic alcoholic and nonalcoholic patients (►**Table 1**; ►**Fig. 3**).

The individual ventricular indices in each age group were analyzed using the one-way ANOVA test to find significance. A statistically significant difference was noted in all the ventricular indices ($p < 0.05$). ►**Table 2** shows that as age increases, there is a gradual increase in the ventricle size (see also ►**Fig. 4**). Similarly, using the Pearson correlation coefficient, each ventricular index was correlated with age. A positive correlation was found between the ventricular indices and age ($p < 0.05$), which indicates that as age increases, the ventricles get dilated.

Discussion

Alcohol consumption is increasing by the day all over the world, which is a major concern. The damage to the brain

Table 1 Mean values of ventricular indices in chronic alcoholic and nonalcoholic patients

Ventricular indices	Groups	*N*	Mean ± SD	*p*-value
Bifrontal index	Chronic alcoholic	43	0.40 ± 0.02	< 0.001[a]
	Nonalcoholic	43	0.32 ± 0.02	
Bicaudate index	Chronic alcoholic	43	0.19 ± 0.02	< 0.001[a]
	Nonalcoholic	43	0.11 ± 0.02	
Ventricular index	Chronic alcoholic	43	0.56 ± 0.04	< 0.001[a]
	Nonalcoholic	43	0.40 ± 0.05	
Evans index	Chronic alcoholic	43	0.33 ± 0.02	< 0.001[a]
	Nonalcoholic	43	0.26 ± 0.02	

Abbreviation: SD, standard deviation.
[a] *p*-value < 0.05 is statistically significant.

Table 2 Comparison of ventricular indices in each age group

Ventricular indices	Age groups (y)	*N*	Mean ± SD	*p*-value
Bifrontal index	30–40	24	0.34 ± 0.04	0.002[a]
	41–50	18	0.35 ± 0.04	
	51–60	44	0.38 ± 0.04	
Bicaudate index	30–40	24	0.14 ± 0.04	0.020[a]
	41–50	18	0.14 ± 0.04	
	51–60	44	0.16 ± 0.04	
Ventricular index	30–40	24	0.46 ± 0.09	0.049[a]
	41–50	18	0.45 ± 0.08	
	51–60	44	0.50 ± 0.08	
Evans index	30–40	24	0.27 ± 0.04	0.011[a]
	41–50	18	0.29 ± 0.03	
	51–60	44	0.31 ± 0.04	

Abbreviation: SD, standard deviation.
[a]*p*-value < 0.05 is statistically significant.

in alcoholics is a social, diagnostic, therapeutic, and prognostic problem.[12] Many studies have proven that there is a strong connection between brain structural changes and alcoholism.[13,14] The morphometric changes in the brain are seen more clearly in chronic alcoholic patients.[6,11] Alcohol is quickly absorbed after consumption and enters the CNS in 2 to 6 hours. The active transport of sodium ions via the choroid plexuses is influenced by alcohol use, which has an impact on the nerve cells. As we know, the choroid plexuses play a vital role in the CNS in maintaining the equilibrium of the CSF within the ventricles. The changes in the membranes and the enzymatic changes affect the circulation of CSF across the membranes, which leads to the accumulation of the fluid or CSF within the choroid epithelium, which causes dilatation of the lateral ventricles.[15]

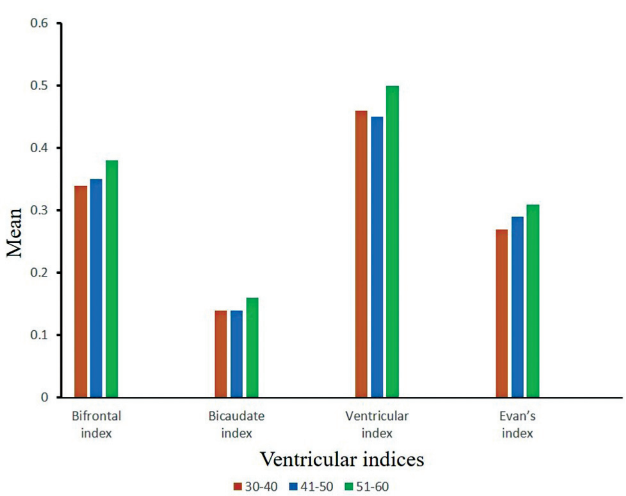

Fig. 4 Comparison of the ventricular indices between patients in each age group.

CT scan is used for diagnoses of many disorders, like brain atrophy and ventricular dilatation.[10,16,17] An increase in the size of the brain's lateral ventricles is the most common observation in chronic alcoholics.[6,18,19] The current study compared chronic alcoholic and nonalcoholic patients by computing the ventricular indices to detect ventricular dilatation. We found a significant difference ($p < 0.05$) in the mean ventricular indices in all groups. Compared to nonalcoholic patients, the average ventricular index values were higher in chronic alcoholic patients of the Mangalore population. A similar result was found by Sandhu et al in their age-matched 106 chronic alcoholic patients and 700 nonalcoholic controls. They also found increased index values in chronic alcoholic patients.[1] A study was carried out in London to examine ventricular system dilatation in chronic alcoholic patients against a control group. The study contained 50 nonalcoholic patients younger than 65 years and 100 alcoholic patients and found that the ventricular index values were higher in chronic alcoholic patients.[20]

Korsakoff's syndrome is a disorder caused by thiamine (vitamin B1) deficiency associated with alcoholism, leading to memory loss.[21] In a study by Jacobson et al, 25 male alcoholic Korsakoff syndrome patients were compared with age- and sex-matched non-Korsakoff's chronic alcoholics and nonalcoholic patients on CT of the brain. They found larger lateral ventricles in alcoholic patients with Korsakoff's syndrome compared to other patient groups.[22] In another study, Emsley et al[23] reported similar results as the above study, comparing alcoholic patients with Korsakoff's syndrome and nonalcoholic controls. A few other investigations have also shown similar findings.[6,7]

In the current study, we found the presence of age-related atrophic changes irrespective of whether the patients were chronic alcoholics and nonalcoholics. However, both the atrophic changes and ventricular indices were higher in chronic alcoholic patients. Multiple studies have found that both chronic alcoholic patients and nonalcoholic patients exhibit age-related changes in the brain.[6,24] It shows that the ventricular index values increase with age and it is significantly greater in the case of chronic alcoholism. A study conducted by Jacobson compared cerebral atrophic changes with age in chronic alcoholic and nonalcoholic patients. The results showed an apparent increase in cerebral atrophic changes in chronic alcoholic patients than the nonalcoholic patients with advanced age.[2] Another study by Cala comprising 115 healthy and 240 alcoholic patients found an increased frontal lobe atrophy with increased age.[18] An abnormally expanded lateral ventricular volume with advancing age was also demonstrated in a study by Pfefferbaum et al.[25]

The left hemisphere is more vulnerable to alcoholism than the right hemisphere, according to a study by Golden et al that examined changes in brain density between chronic alcoholics and healthy controls. This contradicted the idea that alcoholism leads to ventricle expansion because unilateral ventricular enlargement is never observed.[10] Additionally, we did not detect any unilateral ventricular enlargement in the current investigation.

Some studies also found a diffuse and more or less symmetrical shrinkage of the cerebral cortex and dilatation of lateral ventricles.[26] It was also found that few brain damages are reversible if the alcohol intake is reduced entirely.[6,11,27] Chronic alcoholic patients who followed abstinence had decreased quantity of CSF from the enlarged ventricles.[6,11] This is approved by Demirakca et al who studied the effects of alcoholism and continued abstinence on brain volumes in both genders.[11] The reverse of alcoholism-related brain alterations was also demonstrated by Carlen et al and Pfefferbaum et al.[28,29]

The limitations of the current study were that female patients were omitted, as alcohol consumption is observed as a social stigma. Second, only the lateral ventricle was considered in this study. There may or may not be any changes in the other ventricles, but those were not accounted for in this study. Also, we have not considered the other factors that are related to alcoholism, such as duration and quantity of alcohol intake. Other limitations are the exclusion of patients aged between 18 and 29 years and those above 60 years.

Conclusion

The current study showed a significant increase in all the ventricular index values in chronic alcoholics compared to nonalcoholic patients. It can be concluded that ventricular dilatation is seen in chronic alcoholic patients, leading to brain atrophy. They also found that the ventricular index values increase as age increases. These facts prove that alcoholism severely impacts the brain, leading to damage if abstinence is not followed at the correct time. Therefore, our research shows that chronic alcoholic patients will have brain atrophy.

Funding
None.

Conflict of Interest
None declared.

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