Practical one-dimensional measurement approach for diagnosis of cerebral atrophy on cross sectional imaging

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Abstract

BACKGROUND: Cerebral atrophy is the most common finding we encounter in our daily practice. We document it subjectively without an intracranial 3-D software in CT which calculates the cerebral brain volume and is time consuming if available. There is a need for a quantitative parameter for the documentation and detection of cerebral atrophy on sectional imaging. Hence, this study is an attempt to evaluate the role of sylvian fissure depth measurement in diagnosing cerebral atrophy.

AIMS:

To evaluate cerebral atrophy on a single axial section of MDCT Brain by using a quantitative parameter.

MATERIALS & METHODS:

101 patients underwent NCCT BRAIN in our institution. It is a retrospective observational study. In all the patients, brain atrophy was evaluated by measuring sylvian fissure depth on CT brain in axial section, in relation to "cortical atrophy" defined as widening of subarachnoid space.

RESULTS:

Sylvian fissure depth of 13 mm shows sensitivity of 0.976 and specificity of 0.95. It means that the parameter is excellent at detecting cases of cerebral atrophy and excluding individuals who do not have cerebral atrophy.

CONCLUSION:

Sylvian fissure depth of 13 mm on an axial NCCT Brain scan can be reliably used as a quantitative parameter to evaluate cerebral atrophy.

Keywords: Age related cerebral atrophy, cerebral atrophy, sylvian fissure depth.

Introduction

Cerebral atrophy, characterized by the loss of neurons and the connections between them, is a hallmark of various neurodegenerative diseases, including Alzheimer's disease, frontotemporal dementia, and others. Radiologically, cerebral atrophy manifests as a diffuse or focal reduction in brain tissue, often accompanied by widening of the cortical sulci and ventricular enlargement (1).The accurate and early diagnosis of cerebral atrophy is critical for effective disease management and intervention. Traditional diagnostic methods often rely on complex volumetric measurements obtained through advanced imaging techniques, which can be resource-intensive and time-consuming (2). In response to these challenges, there has been a growing interest in developing simpler, yet reliable, measurement approaches.

One-dimensional (1D) measurement techniques offer a promising alternative. These methods focus on linear dimensions, such as cortical thickness or the width of specific brain structures, which can be easily measured on standard radiological images. Previous studies have demonstrated the potential of 1D measurements in providing valuable diagnostic information with less computational burden compared to volumetric analysis (3). The simplicity and practicality of 1D measurements make them particularly suitable for clinical settings where quick decision-making is crucial. The sylvian fissure, also known as the lateral sulcus, is a prominent

feature of the human brain, separating the frontal and parietal lobes from the temporal lobe. Changes in the morphology of the sylvian fissure have been associated with various neurological conditions, including schizophrenia and aging-related atrophy (4). Specifically, increased sylvian fissure depth has been linked to cortical thinning and overall brain atrophy, making it a potential biomarker for cerebral atrophy (5).

In this paper, we propose a practical one-dimensional measurement approach for the diagnosis of cerebral atrophy. This approach leverages the efficiency and ease of 1D measurements to offer a viable diagnostic tool that can be readily implemented in routine clinical practice. We provide a detailed methodology for applying this approach, discuss its advantages and limitations, and present evidence from our study to support its diagnostic efficacy. Our goal is to demonstrate that one-dimensional measurements can serve as a practical and reliable method for the early detection and monitoring of cerebral atrophy, thereby facilitating timely and effective patient care.

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Abbreviations and Acronyms (Heading 2)

CT : computed tomography.
MDCT : multidetector computed tomography.
NCCT: non contrast computed tomography.

I. OBJECTIVES:

- To evaluate cerebral atrophy on a single axial section of MDCT Brain by using a quantitative parameter.
- To simplify the diagnostic process, improve accuracy, and enhance clinical applicability by evaluating the efficacy and reliability of this method compared to existing multi-dimensional techniques.
- Contribute to more accessible and efficient diagnostic processes for cerebral atrophy ultimately improving patient outcomes and aiding in the timely management of neurodegenerative diseases.

II. MATERIALS AND METHODS:

Study center: Rajarajeswari Medical College and Hospital
Source of data: Patients referred to the radiology department.
Study design: Retrospective study.
Sample size: 101

III. INCLUSION CRITERIA

- Patients above the age of 18 years who have undergone CT brain.

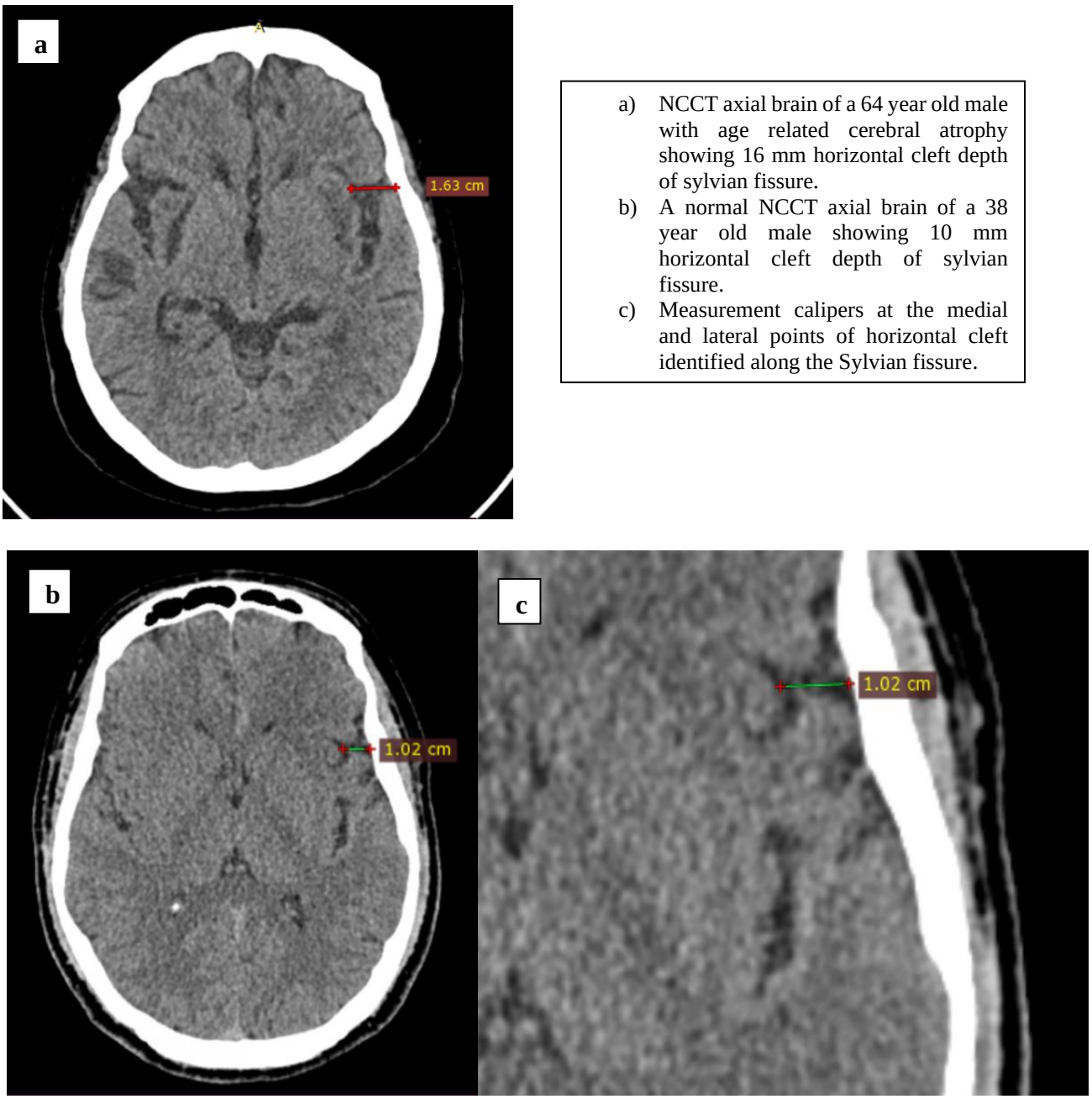
IV. EXCLUSION CRITERIA

- Patients with intracranial hemorrhage or mass lesion.
- h/o head trauma.
- Poor imaging quality.

V. TECHNIQUE:

- The Sylvian fissure appears as a prominent horizontal cleft that separates the frontal and temporal lobes on axial CT brain images.
- Choose the axial slice that displays the Sylvian fissure.
- Use a linear measurement tool available in the CT imaging software.
- Place the measurement cursor or calipers at the medial and lateral points identified along the Sylvian fissure.
- Measure the distance (depth) between these two points.

Image 1



a) NCCT axial brain of a 64 year old male with age related cerebral atrophy showing 16 mm horizontal cleft depth of sylvian fissure.
b) A normal NCCT axial brain of a 38 year old male showing 10 mm horizontal cleft depth of sylvian fissure.
c) Measurement calipers at the medial and lateral points of horizontal cleft identified along the Sylvian fissure.

VI. ETHICAL STATEMENT:

Ethical approval for the study was sought and obtained from the health research and ethics committee of Rajarajeswari Medical College and Hospital. The data obtained was treated with the utmost confidentiality.

VII. STATISTICAL ANALYSIS:

Data collected was entered into a Microsoft excel sheet and was analyzed using SPSS software version 26. Descriptive data was expressed in frequency and percentages.

VIII. RESULTS:

Fig. 1

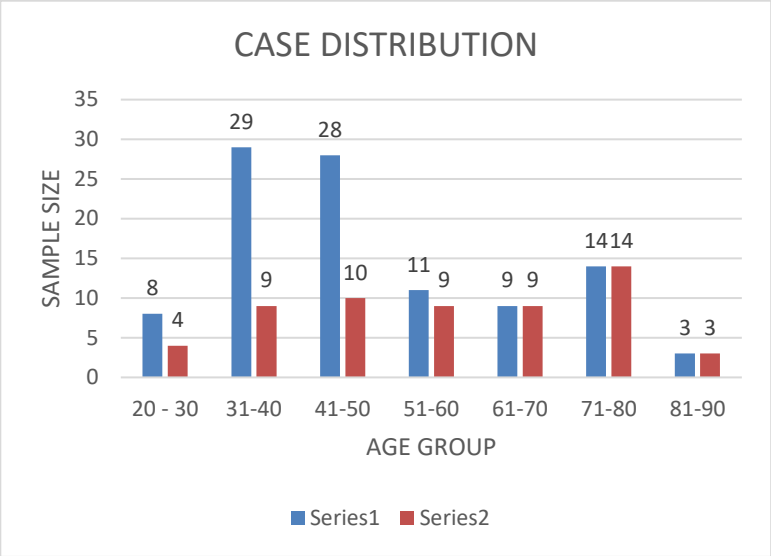
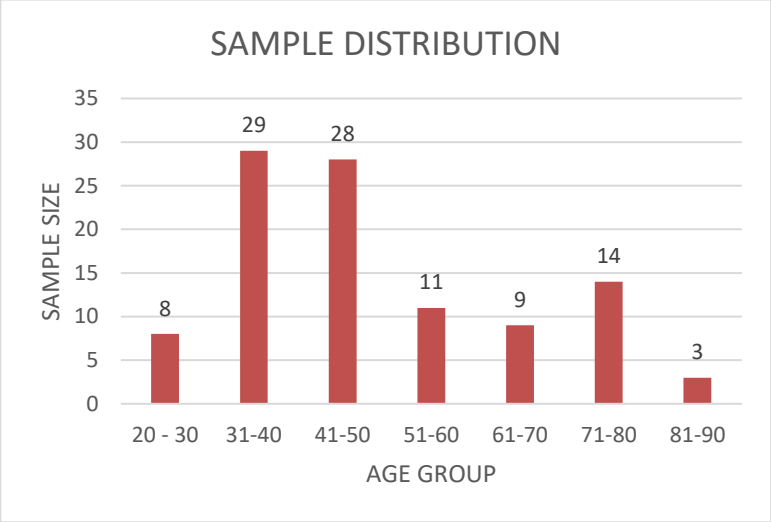


Fig. 2



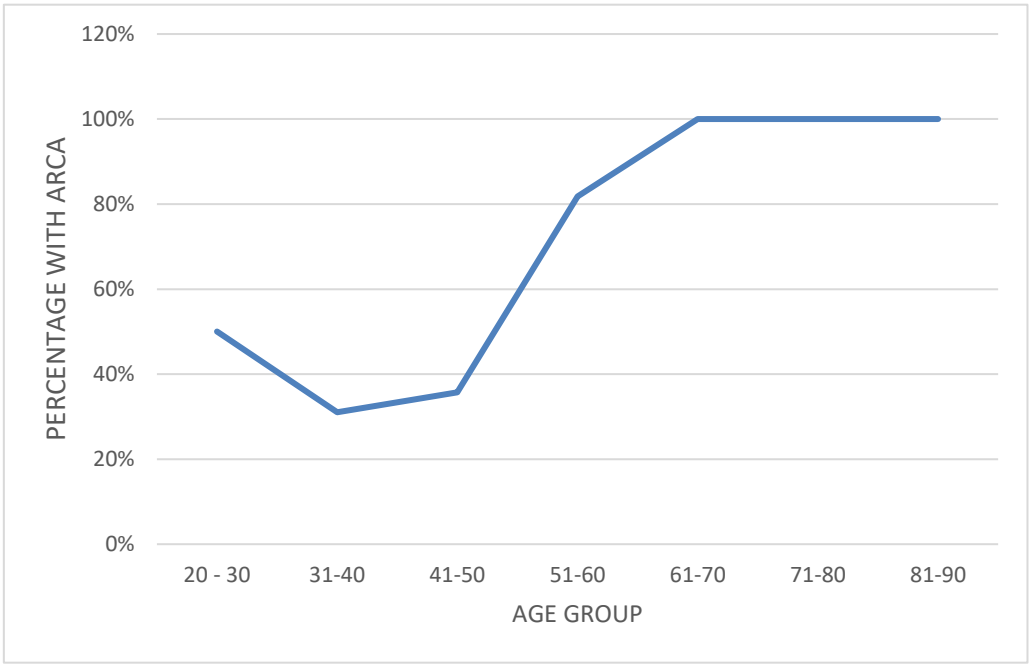
The majority of the study samples are in the 31 to 50 age group. The data indicates that age groups 61 to 90 all are cases of cerebral atrophy and few cases are seen in younger age groups 20-50 there are, suggesting a lower incidence rate of cerebral atrophy in these age groups.

Cerebral atrophy is noted in 41 patients out of 101 in the study, which is approximately 40.6% of the total sample.

Table 1

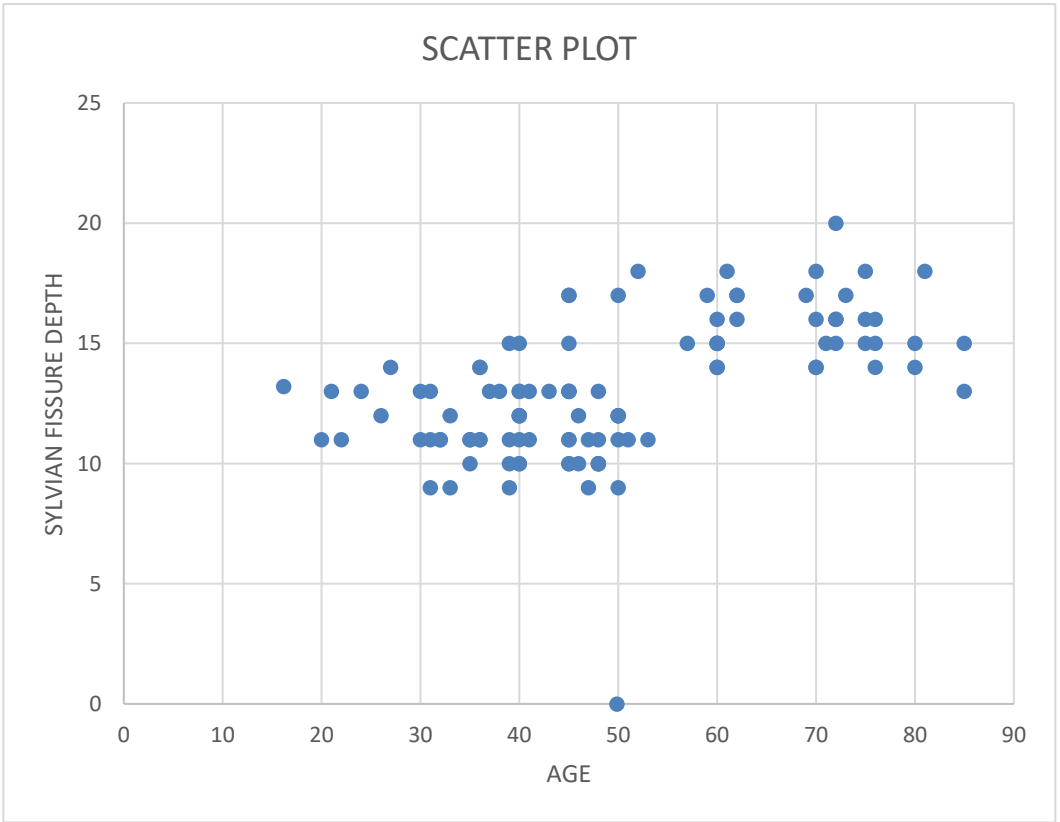
CEREBRAL ATROPHY	NUMBER
PRESENT	41
ABSENT	60

Fig. 3



There is a clear trend where the percentage of individuals with ARCA increases with age, reaching 100% in individuals aged 51 and older. The data shows that cerebral atrophy is more prevalent in older age groups due to factors related to aging and chronic disease processes. However, in younger age groups, the etiology is often linked to genetic, traumatic, infectious, autoimmune, and lifestyle factors. The common etiology noted in the young age group of our study was Alcoholism. Early identification and intervention in younger individuals can help manage and possibly prevent further progression of cerebral atrophy.

Fig. 4



The scatter plot above shows moderate positive correlation means that, on average, as age increases, the depth of the Sylvian fissure also tends to increase.
Moderate Correlation: 0.617003485 as the value lies (between 0.5 -0.75)
STDEV – variation in age = +/- 0.46

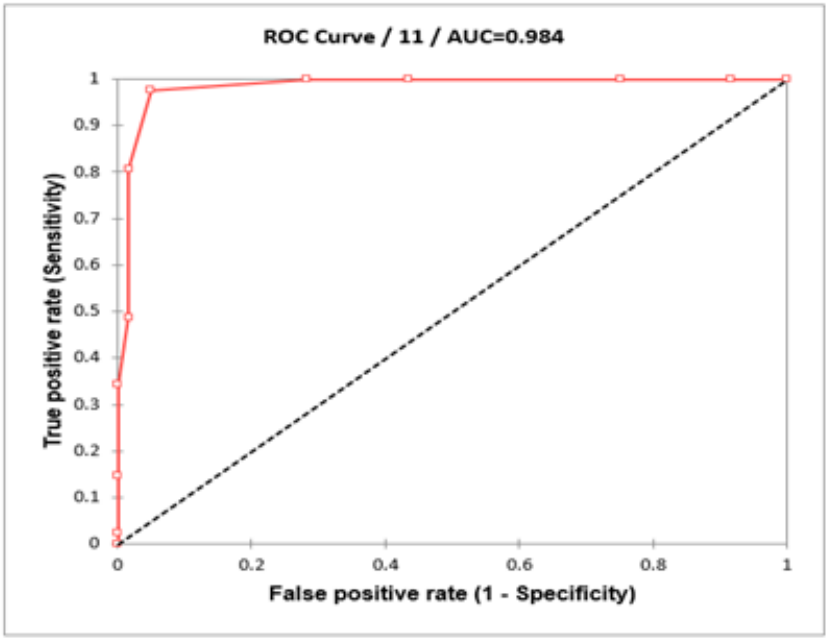
Sylvian fissure depth	Sensitivity	Lower bound (95%)	Upper bound (95%)	Specificity	Lower bound (95%)	Upper bound (95%)	PPV	NPV	Sensitivity+Specificity	Accuracy
11.000	1.000	0.895	1.000	0.567	0.441	0.684	0.612	1.000	1.567	0.743
12.000	1.000	0.895	1.000	0.717	0.591	0.815	0.707	1.000	1.717	0.832
13.000	**0.976**	**0.860**	**1.000**	**0.950**	**0.856**	**0.988**	**0.930**	**0.983**	**1.926**	**0.960**
14.000	0.805	0.656	0.899	0.983	0.901	1.000	0.971	0.881	1.788	0.911
15.000	0.488	0.343	0.635	0.983	0.901	1.000	0.952	0.738	1.471	0.782

Table 2

13 mm shows sensitivity of 0.976 and specificity 0.953.
Sylvian fissure depth of 13 mm correctly identifies 97.6% of individuals with cerebral atrophy and 95.3% of individuals without cerebral atrophy means that the parameter is excellent at detecting cases of cerebral atrophy and excluding individuals who do not have cerebral atrophy. Therefore, minimizing false negatives and false positives.

Fig. 5

Figure: ROC Curve / 11 / AUC=0.984



The area under the curve is 0.984, which shows outstanding result consideration for predicting cerebral atrophy with high accuracy when sylvian fissure depth is 13mm and more.
R= 0.617; Mean= 13.20 mm; Standard deviation = 2.596 mm

p-value (Two-tailed) < 0.0001 (highly significant), indicating that the sylvian fissure depth is increased when cerebral atrophy is present.
As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis.

CONCLUSIONS

- Sylvian fissure depth of 13 mm on an axial NCCT Brain scan can be reliably used as a quantitative parameter to evaluate cerebral atrophy.
- This measurement provides strong discriminatory power, both in detecting true cases of cerebral atrophy and in ruling out individuals who do not have the condition. Consequently, it can be a valuable tool in clinical settings for diagnosing and assessing the progression of cerebral atrophy.

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