A Dissertation on

# "ROLE OF DTI METRICS IN DIFFERENTIATION OF CYSTIC INTRACRANIAL MASS LESIONS"

Submitted to

**THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY**
**CHENNAI – 600032**

In partial fulfilment of the Regulations
for the Award of the Degree of

**M.D. BRANCH - VIII**

**RADIODIAGNOSIS**


**STANLEY MEDICAL COLLEGE**
**CHENNAI – 600 001**

**APRIL 2016**

# CERTIFICATE BY THE INSTITUTION

This is to certify that **Dr. M. PRIYA,** Post - Graduate Student (May 2013 to April 2016) in the Department of Radiodiagnosis, STANLEY MEDICAL COLLEGE, Chennai- 600 001, has done this dissertation on **"ROLE OF DTI METRICS IN DIFFERENTIATION OF CYSTIC INTRACRANIAL MASS LESIONS"** under my guidance and supervision in partial fulfilment of the regulations laid down by the Tamilnadu Dr. M. G. R. Medical University, Chennai, for M.D. (Radiodiagnosis) Degree Examination to be held in April 2016.

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# CERTIFICATE BY THE GUIDE

This is to certify that **Dr. M. PRIYA,** Post - Graduate Student (May 2013 To April 2016) in the Department of Radiodiagnosis STANLEY MEDICAL COLLEGE, Chennai- 600 001, has done this dissertation on **"ROLE OF DTI METRICS IN DIFFERENTIATION OF CYSTIC INTRACRANIAL MASS LESIONS"** under my guidance and supervision in partial fulfilment of the regulations laid down by the Tamilnadu Dr. M.G.R. Medical University, Chennai, for M.D. (Radiodiagnosis), Degree Examination to be held in April 2016.

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Chennai – 600001

# DECLARATION

I **Dr. M. PRIYA,** declare that I carried out this work on **"ROLE OF DTI METRICS IN DIFFERENTIATION OF CYSTIC INTRACRANIAL MASS LESIONS"** at the department of Radiodiagnosis, Government Stanley Hospital. I also declare that this bonafide work or a part of this work was not submitted by me or any other for any award, degree, or diploma to any other university, board either in India or abroad.

This is submitted to The Tamilnadu Dr. M.G.R. Medical University, Chennai in partial fulfilment of the rules and regulation for the M. D. Degree examination in Radiodiagnosis April 2016.

**Dr. M.Priya**

# ACKNOWLEDGEMENT

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I sincerely thank the members of Institutional Ethical Committee, Stanley Medical College for approving my dissertation topic.

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# INTRODUCTION

Diffusion weighted imaging depicts the restriction of random movement of water and thereby gives us the information about the nature of the tissue in which the water molecules are moving[1]. Brown,[2] was first to describe this in 1827 and later quantified by Einstein,[3] in 1905. Pathological processes may directly or indirectly alter the diffusion characteristics of the underlying tissue and can therefore be detected using diffusion weighted imaging techniques[4]. DTI (Diffusion Tensor Imaging) is a non invasive imaging technique that can measure directional variation of water diffusivity for a given voxel by using metrics that quantify diffusion anisotropy, tensor orientation, or tensor shapes.

In brain tissue, water cannot move freely in all the directions as surrounding tissue structures limits its movement, and hence shows preferential movement along certain directions. Likewise it is easier for water to diffuse along the course of a white matter fibre rather than perpendicular to it as the axonal membranes and myelin sheaths act as barriers to the movement of water molecules. This property of preferential movement is known as diffusion anisotropy. It is physically linked to the anisotropy of the tissue structure. Many disease processes affect this diffusion in different ways. Fractional anisotropy (FA) and mean diffusion (MD),[5] are two important Diffusion tensor metrics parameters used to measure and characterize this altered diffusivity in different tissues. Mean diffusion/ADC maps reveal the tendency of the water molecules to

diffuse within a voxel. While other DTI metrics also measure the directional variation and interactions between these directions provides important information about tissue connectivity[6]. The role of DTI to characterise white matter changes in various diseases has already been established.

Cysts and cystic appearing intracranial masses are common findings at MR imaging. The differential diagnosis varies from simple arachnoid cysts to high grade tumours with cystic component, in which case the management grossly differs from cysts which require no treatment to surgery. This differentiation cannot be obtained by conventional MR imaging alone[7-9]. We hypothesize that DTI and the derived indices, fractional anisotrophy FA, mean diffusion MD, geometric tensor metrics, linear anisometry- Cl, planar anisomerty- Cp, spherical anisometry- Cs, is successful in better characterisation of these cysts by reflecting the histological composition of these tissues.

# AIMS AND OBJECTIVES

To study use of diffusion weighted MR in detecting lesion-specific patterns that may assist imaging in better tissue characterization of intra cranial cystic lesions by identifying the cellular component and molecular motion.

# REVIEW OF LITERATURE

Tadeusz W. Stadnika noted that solid gliomas, meningioma, and metastases had same range of ADC values. Lowest ADC values and highest contrast on diffusion-weighted images were observed in association with inflammatory granuloma and abscess.

Kunii N, showed Rathke's cleft cysts are hypointense compared to the normal brain in DWI-SSFSE with a mean ADC of 2.12 x 10(-3) mm(2)/sec. There was a significantly increased ADC, relative ADC with a P value < 0.05 of the Rathke's cleft cysts compared to haemorrhagic components of pituitary adenomas and cystic components of craniopharyngiomas. He proved that there was not a statistically significant (P < 0.05)difference between cystic components of pituitary adenomas and Rathke's cleft cysts.

Reddy JS, noted that 93 lesions were hyperintense on DWI out of 97 brain abscess. These lesions show a statistically significantly low (P = .0001) ADC value (0.87 +/- 0.05 x 10(-3) mm(2)/s) (mean +/- SEM), compared with 48 nonabscess lesions (2.89 +/- 0.05 x 10(-3) mm(2)/s). There was a statistically significant mean ADC of 2.9 +/- 0.05 x 10(-3) mm(2)/s when comparing tumor cysts with neurocysticercosis and benign cysts the.

Mishra AM, analysed Fifty-two patients (tumor cysts [n = 20], abscesses [n = 29], and benign cysts [n = 3]). An ADC value of less than 0.9 +/- 1.3 x 10 mm/s was used as a criteria for the diagnosis of abscess. An ADC values of 1.7-

3.8 x 10 mm/s was used as a criteria for nonabscess cyst. Following which patients were categorized into abscess (n = 29) and nonabscess (n = 23) groups.

Shuda Chen observed mean ADC of epidermoid tumors was 1.197 × $10^{-3}$$mm^2$/s, significantly lower than that of CSF but higher than that of brain tissues.

Santhosh K, noted that highly organised white matter tracts or tissue showed high fractional anisotropy (FA)

Rakesh K. Gupta etal performed diffusion tensor imaging (DTI) in 12 patients with cystic intracranial lesions (pyogenic abscess, $n = 5$; cysticercus cysts, $n = 2$; and low-grade astrocytoma, $n = 5$). Mean FA, $D_{av}$ from the lesion core, perifocal edema, and corresponding contralateral normal-appearing regions were measured and compared for relative changes in these parameters. In the abscess cases, we placed regions of interest on areas with FA >0.2 and FA <0.2 to get FA and $D_{av}$ values.

There were two patterns of FA values in the abscess cavity in all five patients. Part of the abscess showed mean FA = 0.440 ± 0.135, with $D_{av}$ = (0.993 ± 0.185) × $10^{-3}$ $mm^2$/s, whereas other parts had FA = 0.131 ± 0.039 with $D_{av}$ = (0.824 ± 0.183) × $10^{-3}$ $mm^2$/s. The cystic tumors and neurocysticercosis showed very high $D_{av}$ = (2.806 ± 0.25, 2.654 ± 0.35)× $10^{-3}$ $mm^2$/s, with low FA = (0.108 ± 0.037, 0.08 ± 0.01), respectively.

Reiche W,etal noted that abscess is hyperintense on DWI with low MD, high FA and low ADC. Whereas metastatic cysts and glioblastoma cysts were

hypointense on DWI. On DWI 2 out of 10 glioblastoma were similar to abscesses.

C.H. Toh etal observed Abscess was significantly different from glioblastoma for all tensor metrics measured in the cystic cavity and immediate zone of edema and for all except *Cl* in the enhancing rim. Abscess was significantly different from metastasis for all tensor metrics measured in the cystic cavity and enhancing rim and for FA, ADC, and *Cl* in immediate zone of edema. The incidence of a hyperintense FA rim was significantly higher in glioblastoma and metastasis compared with abscess. The 3 tensor metrics with the highest performance in differentiating abscess from glioblastoma and metastasis were FA, *Cl*, and *Cs* of the cystic cavity.

# MATERIALS AND METHODS

The study was approved by the ethical committee and clearance obtained before commencing the study.

**Study design :**

The prospective study was conducted in radiology department at Stanley Medical College Chennai. The study was conducted between August 2013 and July 2015.

**Study population:**

The study group includes a sample size of 62 intra cranial cystic mass lesions, who have come to the department of radiology for MRI. Maximum number of sample size pertaining to a particular diagnosis was restricted to 10.

**Inclusion criteria:**

Patients with intra cranial cystic lesions - who have come to the department of radiology for MRI

**Exclusion criteria:**

Patients with surgical clips and contraindications for MR imaging, were excluded from the study.

**Sample size:**

The study group consisted of 62 patients with intra cranial cystic lesions - who have come to the department of radiology for MRI. Of which there were 10 patients with arachanoid cysts, 2 patients with giant cistern magna, 6 patients with choroidal fissure cyst, 2 patients with ependymal cyst, 3 patients with neuroglial cyst, 2 patients with choroidal plexus cyst, 7 patients with neurocysticercosis, 5 patients with epidermoid cysts 5 patients with abscess, 2 patients with astrocytoma, 1patient with ganglioglioma, 2 patients with cystic metastasis, 2 patients with glioma, 1 patient with astroblastoma, 3 patients with DNET, 2 patients with post operative non tumoral cysts, 1 patient with cystic enchehalomalacia and 1 patients with radiation necrosis- glioblastoma.

**Reference standard:**

The diagnosis of brain abscess and epidermoid cyst were confirmed on surgery in all patients. Histologic diagnosis was obtained in all patients with tumors and metastases by surgical resection. The diagnosis of benign non surgical cyst was confirmed by neuro radiology techniques with consequent follow up and lastly infective cysts by post treatment follow up.

**Consent:**

Informed consent was taken from all the patients enrolled in the study as per the guidance of the ethical committee.

**Patient Evaluation:**

A complete prospective evaluation of all patients was carried out as per the proforma attached.

**Imaging Methods and Analysis:**

Clinical data was collected from all patients and all of them underwent MRI imaging with DTI and MR spectroscopy.

**MR image acquisition:**

**MR image acquisition:**

Imaging was performed on the Siemens MAGNETOM Symphony (Germany) 1.5 T using a head coil (40 element), Gradient strength of 30 mT/m (52 mT/m effective) and slew rate of 125 T/m/s ( 216 T/m/s effective). The MRI protocol consisted of axial, sagittal T1 weighted sequence (T1W) and axial T2 weighted sequence (T2W). DTI was performed in the axial plane by using single-shot echo-planar imaging with the following parameters: TR/TE, 3500/83 ms; diffusion-gradient encoding in 20 directions ;b0, 1000 s/mm$^2$; FOV of 230 X 100 mm; matrix size, 128 X 128; 5 mm section thickness, band width- 1500, EPI factor- 128 average – 3. Standard DWI acquires data in three orthogonal planes (typically X, Y, and Z axis). The complex mathematical equation used to model 3D anisotropy is called tensor. By sampling a minimum of 6 or more diffusion directions and eddy current correction, then establishing a relationship between the acquired data and applied diffusion gradients in the pulse sequence, the

directional variation in the tendency of water molecules to diffuse within a voxel can be imaged. Post processing was done SIEMENS MMWP (Multi Modality Workplace) Neuro 3D software.

## DATA ANALYSIS

**DT-MR Imaging:** Further analysis was done in the workstation after transferring the acquired data. It involves three main steps,[11],

1. Data Preprocessing.
2. Derivation of tensor metrics.
3. Mapping ROIs.

During data preprocessing, raw images were cropped and stripped using a semi automated procedure to remove the scalp for isolating the brain. The DW imaging data were spatially filtered and then distortion-corrected by using the DT-MR imaging toolbox, which calls the 2D perspective models in the automated image and registration package.

For the derivation of tensor metrics, the corrected data were then interpolated to attain isotropic voxels and decoded to obtain the tensor field for each voxel[12]. The DWIs were co-registered to the non-DWIs (b=0) to minimize the artefacts induced by eddy current and subject motion. The diffusion tensor was diagonalized to yield the major,[5] λ1), intermediate (λ 2), and minor (λ 3) eigenvalues. FA- fractional anisotropy,[5] , geometric tensor metrics,[13] (linear

anisometry- Cl, planar anisometry- Cp, and spherical anisometry- Cs), ADC- apparent diffusion coefficient, RA- relative anisometry, GA- Geodesic anisometry were calculated by using the following standard algorithms. DTI provides a very rich dataset that requires some form of data reduction for a more interpretable presentation. It is important that any scalar metric formed from the eigenvalues of the diffusion tensor be rotationally invariant. To facilitate region-of-interest placement for quantitative analysis, the DTI-derived maps were displayed and overlaid on images with different contrasts in the three orthogonal planes for a visual inspection. DTI metric values were obtained by placing the regions of interest on the cavity of cystic lesions on all sections that contained the lesions. Size of the regions of interest was guided by the lesion size, and it was always more than two third of cystic component.

DTI provides a very rich dataset that requires some form of data reduction for a more interpretation. It is important that any scalar metric formed from the eigenvalues of the diffusion tensor be “rotationally invariant,” i.e., the scalar metric is independent of the orientation of the gradient axis direction and the eigenvalue sorting order. Isotropic diffusion is well characterized by the trace of the diffusion tensor

$$Tr(D) = \lambda_1 + \lambda_2 + \lambda_3$$

The trace, or one-third of the trace (i.e., the mean of the eigenvalues), is also an important scalar metric for anisotropic media, since it represents the average diffusivity of the media. Typically, this quantity is

referred to as the ADC. Since the trace is scalar invariant, one need not determine the full tensor to measure ADC; the sum of the diffusion coefficients measured along any three orthogonal directions is sufficient to measure the trace or the ADC. However, more importantly for the clinical application of the investigation of white-matter integrity, metrics of diffusion anisotropy are more appropriate. Two very useful metrics are FA, which is a measure of the portion of the magnitude of the diffusion tensor due to anisotropy,

$$FA = \sqrt{1/2} \quad \frac{\sqrt{(\lambda_1-\lambda_2)^2 + (\lambda_2-\lambda_3)^2 + (\lambda_3-\lambda_1)^2}}{\sqrt{(\lambda_1^2+\lambda_2^2+\lambda_3^2)^2}}$$

and relative anisotropy (RA), derived from a ratio of the anisotropic portion of the diffusion tensor to the isotropic portion,

$$RA = \frac{\sqrt{((\lambda_1-\lambda_2)^2 + (\lambda_2-\lambda_3)^2 + (\lambda_3-\lambda_1)^2}}{TRACE}$$

Both anisotropy indices, which are dimensionless but quantitative, acquire a value of 0.0 for a purely isotropic medium. For a highly anisotropic, cylindrically symmetric medium $(\lambda_1 > \lambda_2 = \lambda_3)$ FA tends towards 1, while RA tends towards √2. Both FA and RA maps can be presented as gray scale images for evaluation. Another form of data presentation is the combination of the eigenvalue information into a colour image. By choosing the eigenvector (1) associated with the largest eigenvalue, the principal diffusion direction of the underlying brain structure can be encoded with colour and the magnitude of the anisotropy, such as FA, can be further used as an illumination factor of the

calculation of a directionally encoded colour image. This results in a calculation of the colour components (R, G, and B) of a pixel given by:

$$R = FA|\varepsilon_x^1|,\ G = FA|\varepsilon_y^1|,\ B = FA|\varepsilon_z^1|$$

$$C_L = \frac{\lambda_1-\lambda_2}{\lambda_1+\lambda_2+\lambda_3}$$

$$C_P = \frac{2\,(\lambda_2-\lambda_3)}{\lambda_1+\lambda_2+\lambda_3}$$

$$C_P = \frac{3\,\lambda_3}{\lambda_1+\lambda_2+\lambda_3}$$

$$GA = \sqrt{\text{Trace}\,(\log S - \langle \log S \rangle I)^2} \qquad \langle \log S \rangle = \frac{\text{Trace}(\log S)}{3}$$

The trace, or one-third of the trace (i.e., the mean of the eigenvalues), is also an important scalar metric for anisotropic media, since it represents the average diffusivity of the media. Typically, this quantity is referred to as the ADC. Since the trace is scalar invariant, one need not determine the full tensor to measure ADC; the sum of the diffusion coefficients measured along any three orthogonal directions is sufficient to measure the trace or the ADC.

**Image analysis:**

MR imaging features were assessed by qualified radiologists with experience of nine years. From the DTI data several other diffusion maps or indices can be calculated.

# STATISTICAL ANALYSIS

All the data were entered into the excel sheet. The final diagnoses were based on histopathology or presumptive diagnoses were made based on imaging finding and post treatment clinical response or by serial imaging. Diagnostic accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of DTI for the differentiation of intra cranial cystic lesions were calculated. Kruskal-Wallis & Mann-Whitney U Test with Bonferroni correction for multiple pair wise comparison was done to compare between the groups. Comparison of all the non normally distributed continuous variables were being tested by mann-whitney U test. Cut off values for FA, MD, RA, VR, TRACE, B0, GA, Cl, Cp, and Cs for distinguishing various groups of cysts were determined by ROC curve analysis. The ROC curve was further used to calculate the AUC value, which is an index of overall discriminative ability of a DTI metric to discriminate between intracranial cysts. A commercially available statistical software package (Statistical Package for the Social Sciences, Version17; SPSS, Chicago, Illinois) was used for analysis, and P values < .05 were considered statistically significant.

## RESULTS

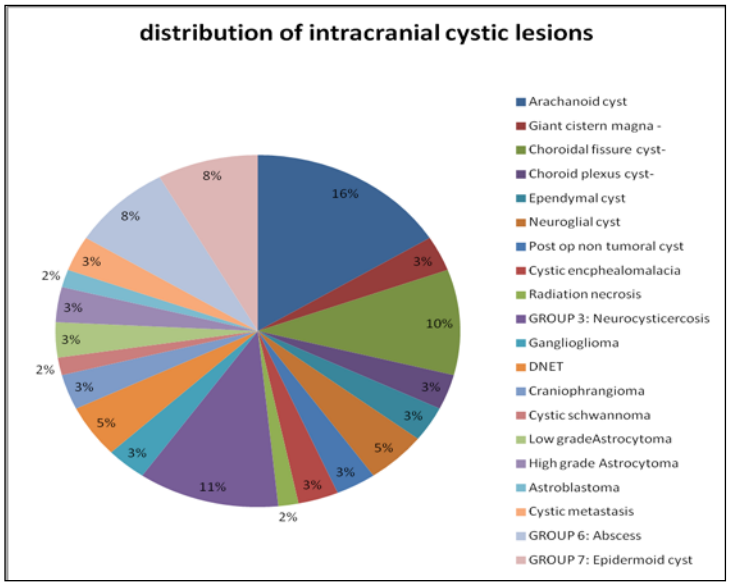
A total of 62 patients with intracranial cysts were analyzed. Intracranial cysts were classified according to its etiology and also based on kind of the management.

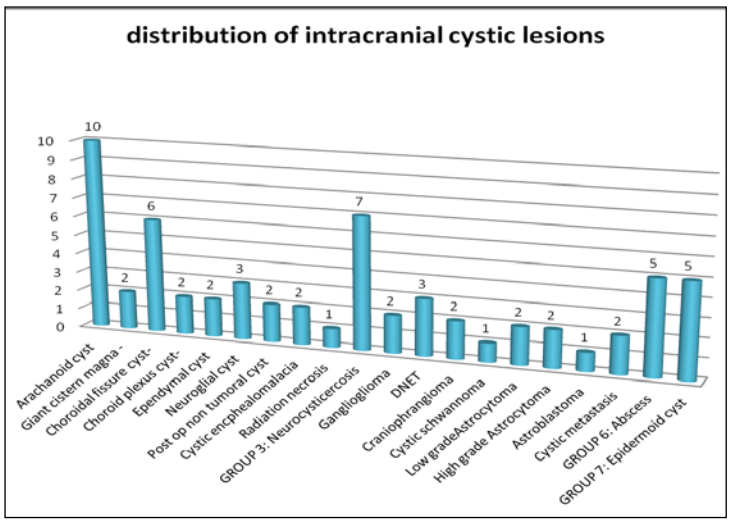
Hence the cysts were classified into 7 groups for statistical comparison as follows:

| | |
|---|---|
| **GPOUP 1: maldevelopmental cysts** | **(25)** |
| Arachanoid cyst | **10** |
| Giant cistern magna - | **2** |
| Choroidal fissure cyst- | **6** |
| Choroid plexus cyst- | **2** |
| Ependymal cyst | **2** |
| Neuroglial cyst | **3** |
| **GROUP 2:acquired porencephalic cyst** | **(5)** |
| Post op non tumoral cyst | **2** |
| Cystic encphealomalacia | **2** |
| Radiation necrosis | **1** |
| **GROUP 3: Neurocysticercosis** | **7** |
| **GROUP 4:low grade neoplastic cyst** | **(10)** |
| Ganglioglioma | **2** |
| DNET | **3** |
| Craniophrangioma | **2** |
| Cystic schwannoma | **1** |
| Low gradeAstrocytoma | **2** |
| **GROUP 5: high grade neoplastic cyst** | **(5)** |
| High grade Astrocytoma | **2** |
| Astroblastoma | **1** |

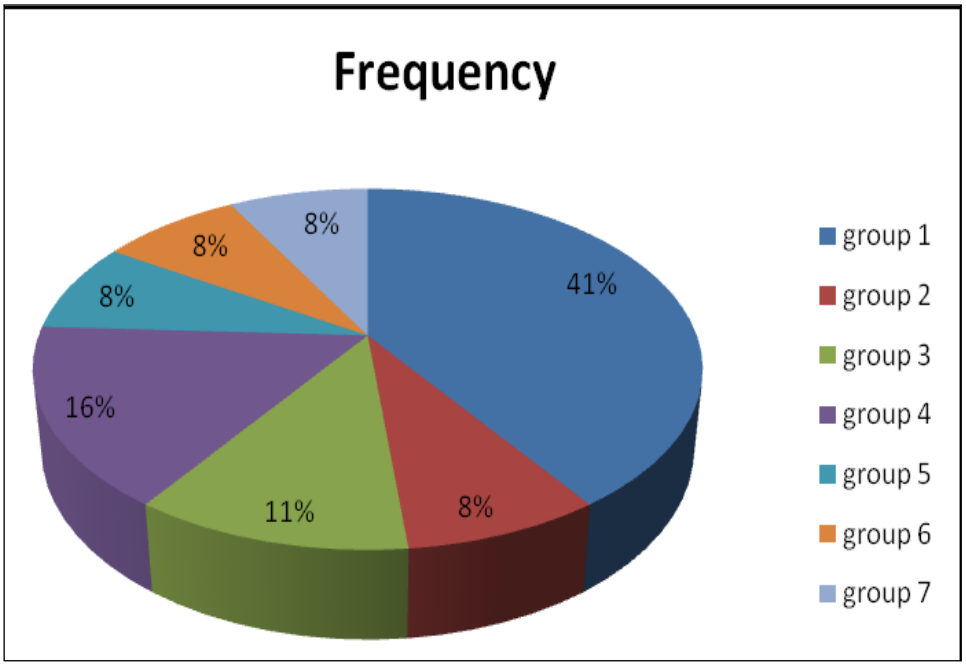
| | |
|---|---|
| Cystic metastasis | **2** |
| **GROUP 6: Abscess** | **5** |
| **GROUP 7: Epidermoid cyst** | **5** |
| **Total** | **62** |

Of these, Group 1 cysts were 25 patients (40%), Group 2 in 5 patients (8%), Group 3 in 7 patients (11%), Group 4 in 10 patients (16%) , Group 5 in 5 patients(8%) , Group 6 in 5 patients(8%) and Group 7 in 5 patients (8%).



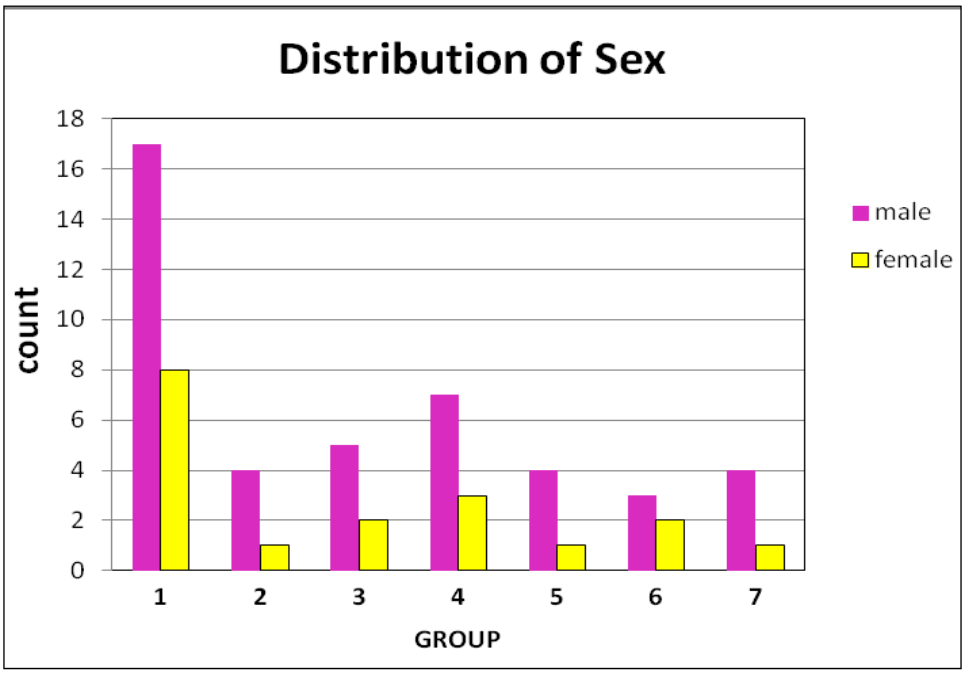



| Cyst Group | Frequency | Percent |
|---|---|---|
| 1 | 25 | 40.3 |
| 2 | 5 | 8.1 |
| 3 | 7 | 11.3 |
| 4 | 10 | 16.1 |
| 5 | 5 | 8.1 |
| 6 | 5 | 8.1 |
| 7 | 5 | 8.1 |
| Total | 62 | 100.0 |




**Distribution of male & females in various groups**

| Group | Male | Female |
|---|---|---|
| 1 | 17 | 8 |
| 2 | 4 | 1 |
| 3 | 5 | 2 |
| 4 | 7 | 3 |
| 5 | 4 | 1 |
| 6 | 3 | 2 |
| 7 | 4 | 1 |
| TOTAL | 44 | 18 |




**Distribution of male & females in each group**

**Gender-wise distribution of the study subjects**

| S. No | Gender | No of subjects (62) | percentage |
|---|---|---|---|
| 1 | Male | 44 | 71% |
| 2 | Female | 18 | 29% |

Note – Datas are the number of studies and percentages

There existed a male preponderance in the study population with 71% males and 29% female subjects.

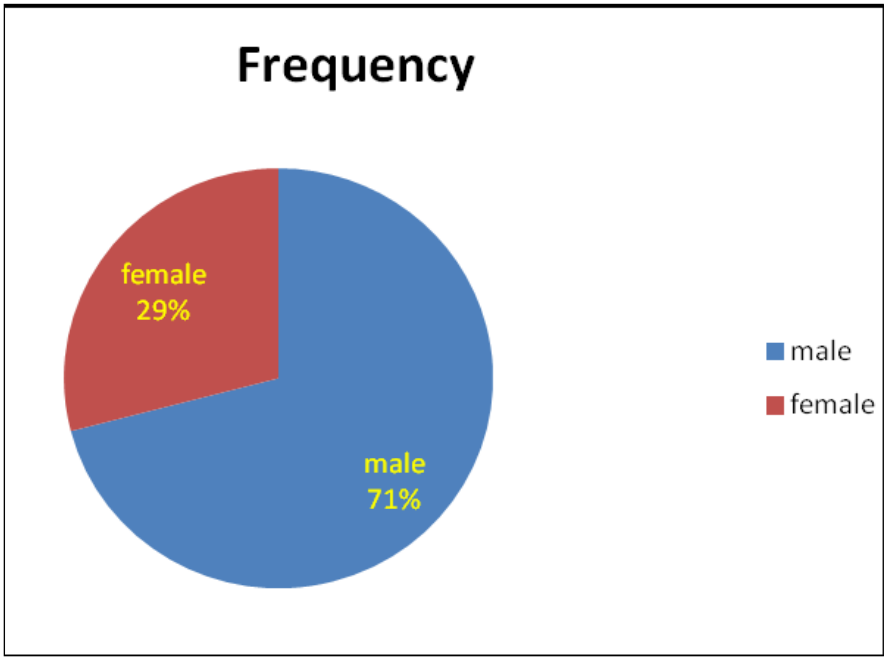
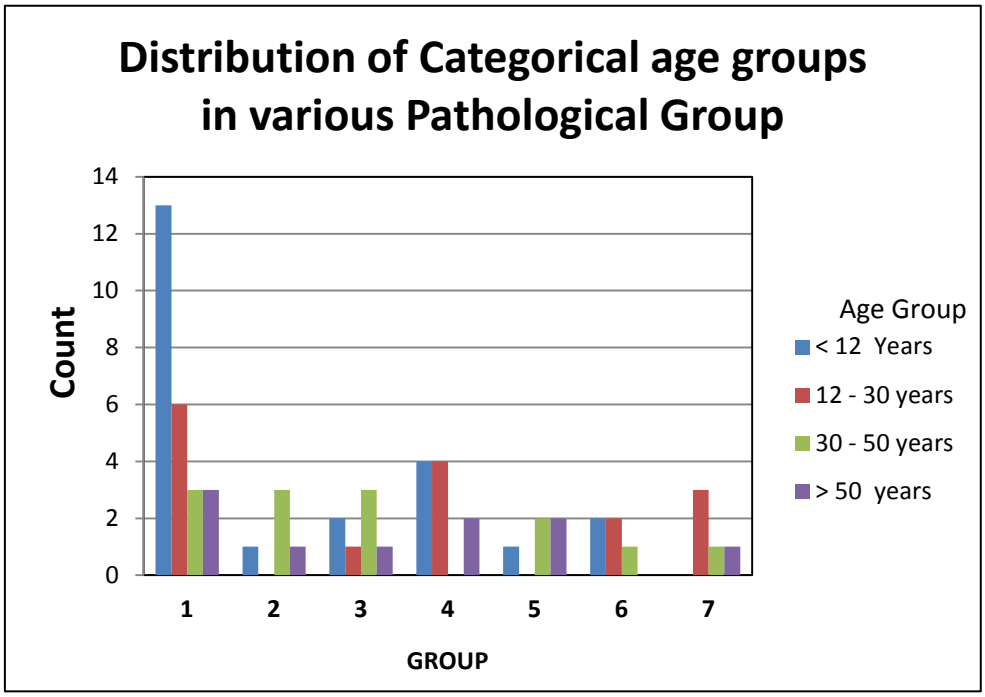
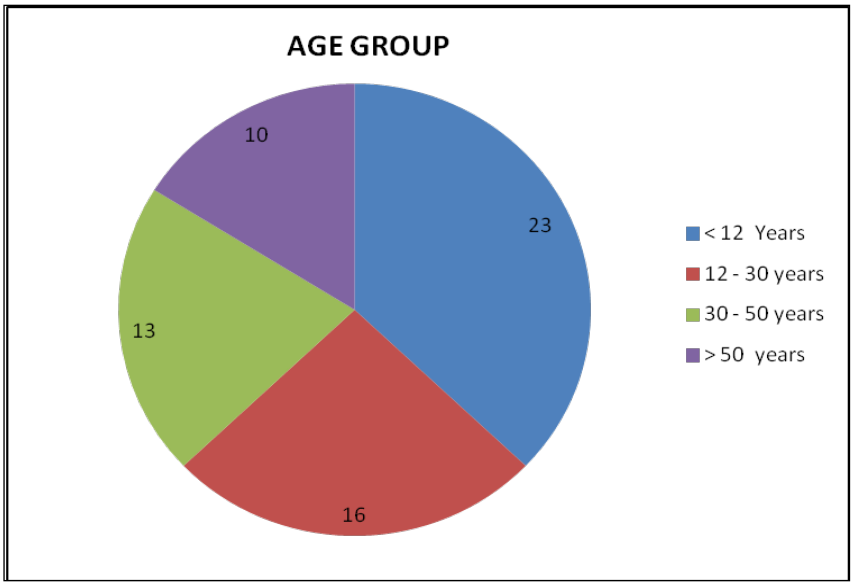


**Table : Age distribution of the study objects**

| Group | Age Group | | | |
|---|---|---|---|---|
| | < 12 Years | 12 - 30 years | 30 - 50 years | > 50 years |
| 1 | 13 | 6 | 3 | 3 |
| 2 | 1 | 0 | 3 | 1 |
| 3 | 2 | 1 | 3 | 1 |
| 4 | 4 | 4 | 0 | 2 |
| 5 | 1 | 0 | 2 | 2 |
| 6 | 2 | 2 | 1 | 0 |
| 7 | 0 | 3 | 1 | 1 |
| TOTAL | 23 | 16 | 13 | 10 |






The Commonest age group involved was less than 12 years, accounting for 37% of the cases. The age group ranged from 6 months to 87 years.

**Size of intracranial cystic lesions:**

Mean size: 27.5mm, Minimum size : 5.5mm, Maximum size : 60.6mm

| < 10mm | 10-20mm | 20-30mm | >30mm | Total |
|---|---|---|---|---|
| 12 | 11 | 10 | 29 | 62 |

**Table: Mean of the DTI parameters in 7 groups**

| G | FA | MD | RA | VR | GA | CL | CP | CS | B0 | TRACE |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .098 | 2.838 | 75.05 | 983.40 | 138.21 | 36.68 | 55.100 | 908.17 | 598.25 | 35.040 |
| 2 | .056 | 2.524 | 41.50 | 996.66 | 102.84 | 17.64 | 31.000 | 951.30 | 748.32 | 79.060 |
| 3 | .276 | 2.405 | 57.37 | 963.18 | 95.34 | 36.78 | 63.029 | 900.04 | 769.74 | 50.957 |
| 4 | .084 | 2.691 | 64.05 | 990.09 | 108.77 | 28.02 | 38.360 | 933.74 | 672.92 | 57.440 |
| 5 | .060 | 2.498 | 49.40 | 995.86 | 85.60 | 20.82 | 37.600 | 941.50 | 713.68 | 68.040 |
| 6 | .078 | .777 | 56.84 | 988.88 | 78.76 | 17.64 | 37.440 | 944.94 | 651.00 | 239.94 |
| **7** | .509 | .866 | 477.2 | 686.20 | 920.00 | 218.5 | 332.92 | 448.62 | 859.34 | 413.60 |

YELLOW- HIGHEST VALUE RED- LOWEST VALUE

**Kruskal-Wallis Test** – Statistical comparison between groups for each of the DTI parameter

| Variables | Cyst Group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-1 | 25 | 31.74 | <0.001 |
| | Group-2 | 5 | 9.20 | |
| | Group-3 | 7 | 51.57 | |
| | Group-4 | 10 | 27.85 | |
| | Group-5 | 5 | 12.50 | |
| | Group-6 | 5 | 23.30 | |
| | Group-7 | 5 | 59.00 | |
| | Total | 62 | | |
| MD | Group-1 | 25 | 41.94 | <0.001 |
| | Group-2 | 5 | 35.50 | |
| | Group-3 | 7 | 25.93 | |
| | Group-4 | 10 | 34.15 | |
| | Group-5 | 5 | 28.80 | |
| | Group-6 | 5 | 4.80 | |
| | Group-7 | 5 | 7.20 | |
| | Total | 62 | | |
| RA | Group-1 | 25 | 36.00 | <0.001 |
| | Group-2 | 5 | 6.80 | |
| | Group-3 | 7 | 27.43 | |
| | Group-4 | 10 | 30.55 | |
| | Group-5 | 5 | 16.50 | |
| | Group-6 | 5 | 27.80 | |

| | | | | |
|---|---|---|---|---|
| | Group-7 | 5 | 60.00 | |
| | Total | 62 | | |
| VR | Group-1 | 25 | 30.66 | <0.001 |
| | Group-2 | 5 | 54.20 | |
| | Group-3 | 7 | 18.71 | |
| | Group-4 | 10 | 33.75 | |
| | Group-5 | 5 | 50.10 | |
| | Group-6 | 5 | 36.30 | |
| | Group-7 | 5 | 3.00 | |
| | Total | 62 | | |

| Variables | Cyst Group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| GA | Group-1 | 25 | 40.44 | <0.001 |
| | Group-2 | 5 | 20.20 | |
| | Group-3 | 7 | 22.57 | |
| | Group-4 | 10 | 25.60 | |
| | Group-5 | 5 | 14.20 | |
| | Group-6 | 5 | 11.20 | |
| | Group-7 | 5 | 60.00 | |
| | Total | 62 | | |
| CL | Group-1 | 25 | 36.88 | <0.001 |
| | Group-2 | 5 | 11.60 | |
| | Group-3 | 7 | 32.93 | |

| | | | | |
|---|---|---|---|---|
| | Group-4 | 10 | 28.40 | |
| | Group-5 | 5 | 17.70 | |
| | Group-6 | 5 | 14.00 | |
| | Group-7 | 5 | 60.00 | |
| | Total | 62 | | |
| CP | Group-1 | 25 | 37.18 | <0.001 |
| | Group-2 | 5 | 12.50 | |
| | Group-3 | 7 | 32.14 | |
| | Group-4 | 10 | 21.10 | |
| | Group-5 | 5 | 23.50 | |
| | Group-6 | 5 | 21.50 | |
| | Group-7 | 5 | 60.00 | |
| | Total | 62 | | |
| CS | Group-1 | 25 | 25.68 | <0.001 |
| | Group-2 | 5 | 51.40 | |
| | Group-3 | 7 | 30.71 | |
| | Group-4 | 10 | 37.90 | |
| | Group-5 | 5 | 41.40 | |
| | Group-6 | 5 | 47.60 | |
| | Group-7 | 5 | 3.00 | |
| | Total | 62 | | |

| Variables | Cyst Group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| BO | Group-1 | 25 | 21.12 | 0.001 |
| | Group-2 | 5 | 38.60 | |
| | Group-3 | 7 | 44.86 | |
| | Group-4 | 10 | 32.00 | |
| | Group-5 | 5 | 36.80 | |
| | Group-6 | 5 | 27.00 | |
| | Group-7 | 5 | 55.80 | |
| | Total | 62 | | |
| TRACE W | Group-1 | 25 | 16.84 | <0.001 |
| | Group-2 | 5 | 33.00 | |
| | Group-3 | 7 | 35.43 | |
| | Group-4 | 10 | 35.90 | |
| | Group-5 | 5 | 37.60 | |
| | Group-6 | 5 | 54.40 | |
| | Group-7 | 5 | 60.00 | |
| | Total | 62 | | |

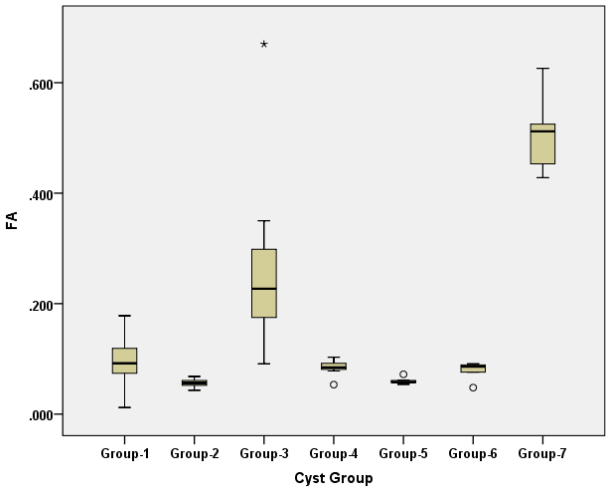
Statistical comparison between the groups for each of the DTI metric shows a P value of $< 0.05$, indicating that the difference in each of the parameter is statistically significant there by showing that the group allocation is perfect.

**Descriptive Statistics**

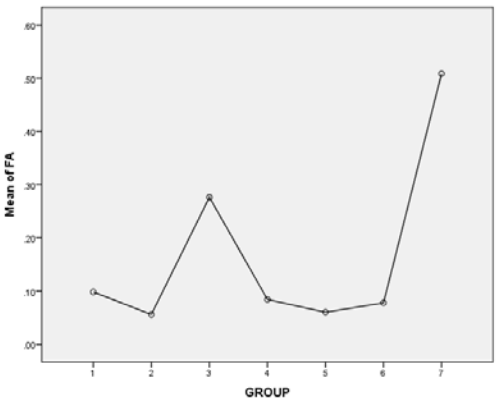
The diffusion tensor metric values derived from all regions of interest and the statistical results of between-group comparisons are listed in following Tables.

**Table 1 FA Values**

| | FA | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group-1 | 25 | .098 | .039 | .012 | .074 | .092 | .119 | .178 |
| Group-2 | 5 | .056 | .009 | .043 | .052 | .057 | .061 | .068 |
| Group-3 | 7 | .276 | .192 | .091 | .137 | .227 | .350 | .670 |
| Group-4 | 10 | .084 | .013 | .053 | .081 | .084 | .092 | .103 |
| Group-5 | 5 | .060 | .007 | .054 | .057 | .058 | .061 | .072 |
| Group-6 | 5 | .078 | .018 | .048 | .076 | .086 | .089 | .091 |
| Group-7 | 5 | .509 | .077 | .428 | .453 | .512 | .525 | .626 |
| Total | 62 | .141 | .144 | .012 | .069 | .089 | .137 | .670 |



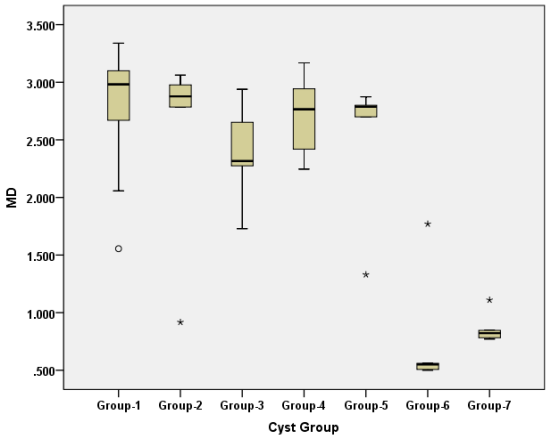

Boxplots of the central region for groups I–VII.



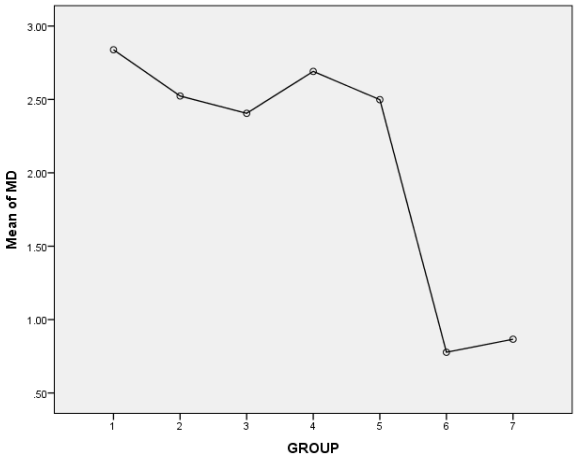

FA -MEAN PLOT

**Table 2 MD Values**

| | MD | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 2.838 | .430 | 1.555 | 2.670 | 2.982 | 3.100 | 3.339 |
| Group- | 5 | 2.524 | .904 | .917 | 2.785 | 2.877 | 2.977 | 3.062 |
| Group- | 7 | 2.405 | .410 | 1.729 | 2.240 | 2.316 | 2.877 | 2.939 |
| Group- | 10 | 2.691 | .315 | 2.246 | 2.420 | 2.766 | 2.943 | 3.168 |
| Group- | 5 | 2.498 | .656 | 1.330 | 2.700 | 2.788 | 2.800 | 2.874 |
| Group- | 5 | .777 | .555 | .500 | .507 | .550 | .560 | 1.770 |
| Group- | 5 | .866 | .140 | .771 | .782 | .822 | .846 | 1.110 |
| Total | 62 | 2.388 | .843 | .500 | 2.199 | 2.787 | 2.977 | 3.339 |



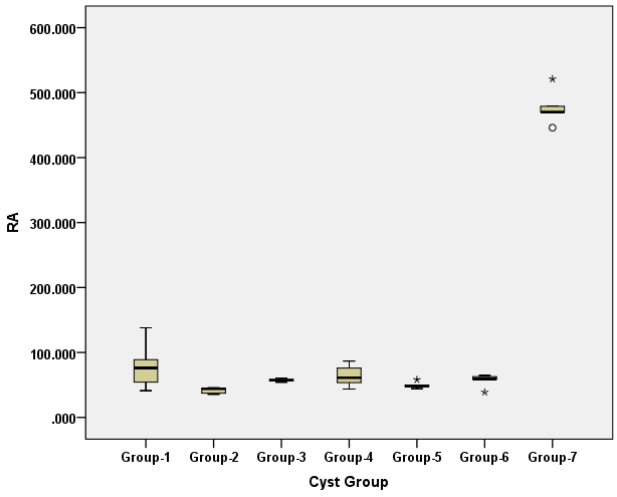

Boxplots of the central region for groups I–VII.



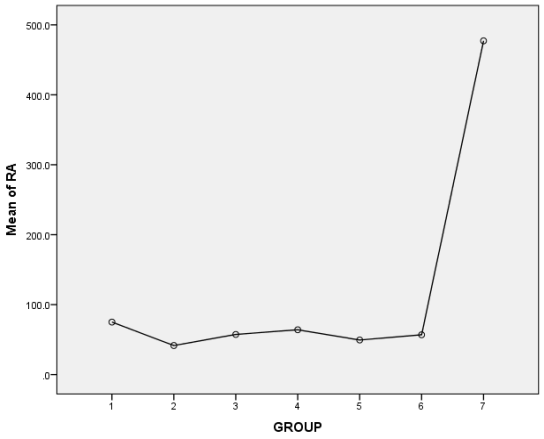

MD -MEAN PLOT

**Table 3 RA Values**

| | RA | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 75.056 | 25.641 | 41.200 | 54.400 | 76.200 | 88.900 | 138.000 |
| Group- | 5 | 41.500 | 4.643 | 35.600 | 37.400 | 44.000 | 44.900 | 45.600 |
| Group- | 7 | 57.371 | 2.065 | 54.200 | 55.800 | 57.100 | 59.400 | 60.200 |
| Group- | 10 | 64.050 | 14.516 | 43.600 | 53.600 | 61.050 | 76.000 | 86.800 |
| Group- | 5 | 49.400 | 5.254 | 44.300 | 47.200 | 47.500 | 49.900 | 58.100 |
| Group- | 5 | 56.840 | 10.375 | 38.800 | 58.800 | 59.200 | 62.800 | 64.600 |
| Group- | 5 | 477.200 | 27.381 | 446.000 | 470.000 | 470.000 | 479.000 | 521.000 |
| Total | 62 | 97.471 | 115.429 | 35.600 | 49.700 | 59.000 | 82.200 | 521.000 |



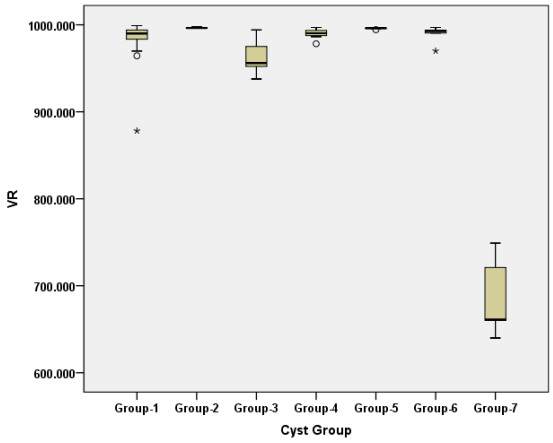

Boxplots of the central region for groups I–VII.



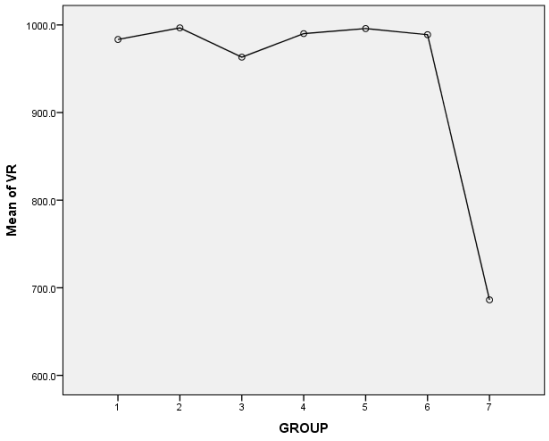

RA -MEAN PLOT

**Table 4 VR Values**

| | VR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 983.404 | 23.518 | 878.200 | 983.500 | 990.000 | 994.000 | 999.100 |
| Group- | 5 | 996.660 | .853 | 996.000 | 996.000 | 996.300 | 997.000 | 998.000 |
| Group- | 7 | 963.186 | 21.983 | 937.700 | 951.300 | 956.000 | 994.000 | 994.100 |
| Group- | 10 | 990.090 | 5.506 | 978.200 | 987.600 | 990.300 | 993.500 | 997.000 |
| Group- | 5 | 995.860 | .891 | 994.400 | 995.700 | 996.200 | 996.300 | 996.700 |
| Group- | 5 | 988.880 | 10.800 | 970.000 | 990.600 | 993.000 | 993.800 | 997.000 |
| Group- | 5 | 686.200 | 46.397 | 640.000 | 660.000 | 661.000 | 721.000 | 749.000 |
| Total | 62 | 960.747 | 84.975 | 640.000 | 978.200 | 990.650 | 995.000 | 999.100 |



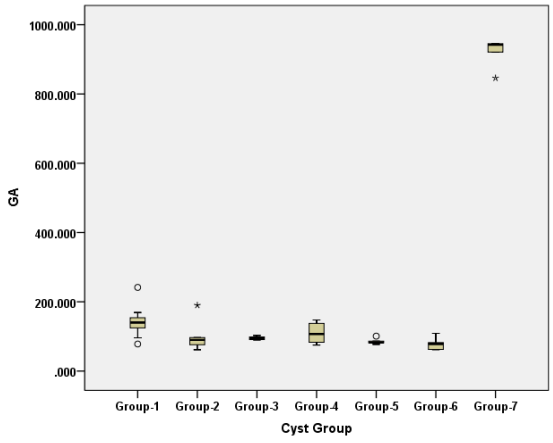

Boxplots of the central region for groups I–VII.

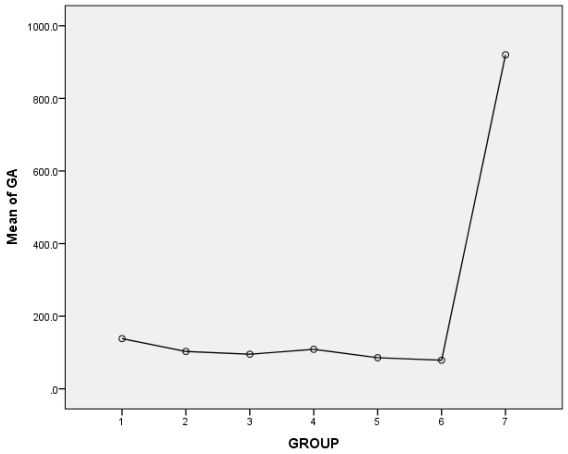



VR -MEAN PLOT

**Table 5 GA Values**

| | GA | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 138.216 | 33.061 | 78.100 | 124.600 | 140.000 | 154.100 | 241.500 |
| Group- | 5 | 102.840 | 50.474 | 61.700 | 76.200 | 89.800 | 96.600 | 189.900 |
| Group- | 7 | 95.343 | 5.031 | 89.900 | 90.200 | 95.600 | 99.200 | 102.900 |
| Group- | 10 | 108.770 | 28.613 | 75.200 | 83.200 | 106.850 | 137.400 | 147.500 |
| Group- | 5 | 85.600 | 9.157 | 76.900 | 81.400 | 82.400 | 86.500 | 100.800 |
| Group- | 5 | 78.760 | 19.125 | 61.900 | 62.500 | 78.400 | 82.200 | 108.800 |
| Group- | 5 | 920.000 | 42.609 | 846.000 | 921.000 | 942.000 | 945.000 | 946.000 |
| Total | 62 | 179.782 | 224.014 | 61.700 | 89.800 | 111.500 | 147.500 | 946.000 |



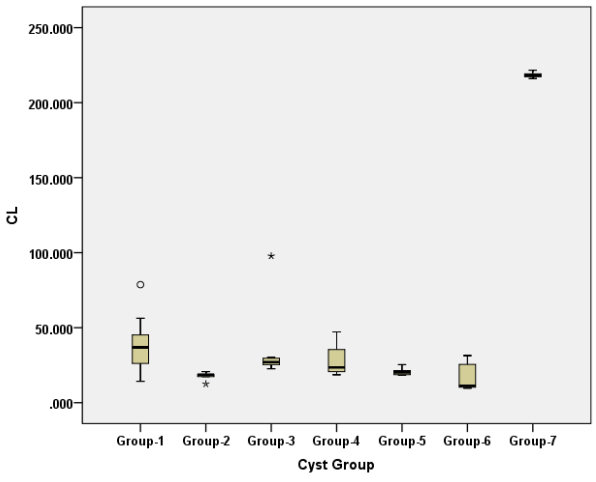



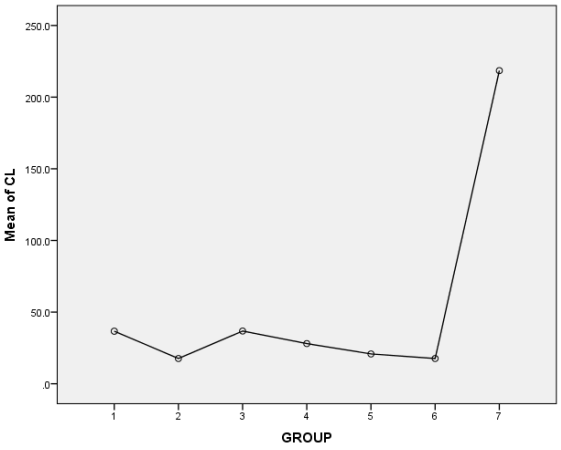

Boxplots of the central region for groups I–VII.

GA -MEAN PLOT

**Table 6 CL Values**

| | CL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 36.680 | 15.265 | 14.300 | 26.200 | 36.900 | 45.200 | 78.700 |
| Group- | 5 | 17.640 | 3.105 | 12.500 | 17.400 | 18.700 | 18.900 | 20.700 |
| Group- | 7 | 36.786 | 27.024 | 22.600 | 24.700 | 27.100 | 30.100 | 97.800 |
| Group- | 10 | 28.020 | 9.575 | 18.600 | 20.700 | 23.500 | 35.400 | 47.200 |
| Group- | 5 | 20.820 | 2.831 | 18.400 | 18.700 | 20.200 | 21.400 | 25.400 |
| Group- | 5 | 17.640 | 10.102 | 9.700 | 10.300 | 11.300 | 25.500 | 31.400 |
| Group- | 5 | 218.500 | 2.082 | 216.100 | 217.300 | 218.300 | 219.200 | 221.600 |
| Total | 62 | 45.608 | 53.909 | 9.700 | 20.100 | 28.100 | 40.200 | 221.600 |



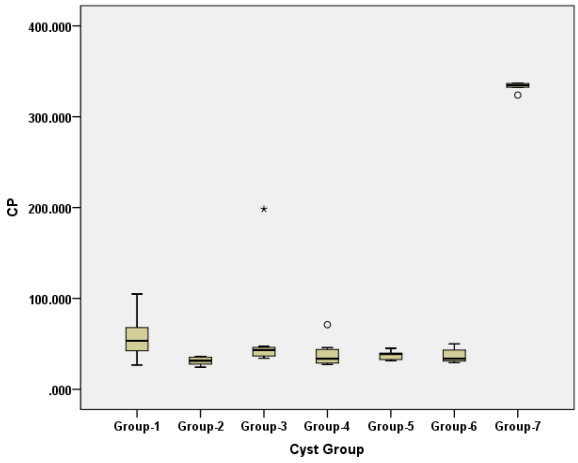



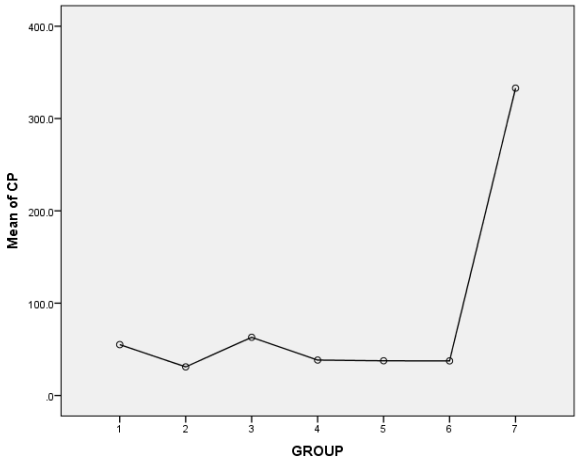

Boxplots of the central region for groups I–VII.

CL -MEAN PLOT

**Table 7 CP Values**

| | CP | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 55.100 | 19.995 | 26.700 | 42.400 | 53.400 | 67.900 | 104.800 |
| Group- | 5 | 31.000 | 5.008 | 24.400 | 27.700 | 31.400 | 35.200 | 36.300 |
| Group- | 7 | 63.029 | 59.896 | 34.100 | 36.100 | 43.200 | 47.200 | 198.400 |
| Group- | 10 | 38.360 | 13.354 | 27.300 | 28.900 | 33.650 | 43.800 | 71.100 |
| Group- | 5 | 37.600 | 5.540 | 31.500 | 32.800 | 38.800 | 39.800 | 45.100 |
| Group- | 5 | 37.440 | 8.841 | 29.300 | 31.000 | 33.700 | 43.200 | 50.000 |
| Group- | 5 | 332.920 | 5.434 | 323.800 | 332.400 | 334.600 | 336.600 | 337.200 |
| Total | 62 | 70.921 | 82.285 | 24.400 | 32.800 | 43.500 | 65.300 | 337.200 |



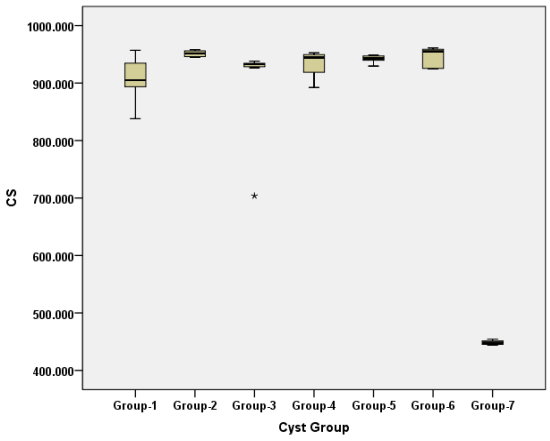




Boxplots of the central region for groups I–VII.

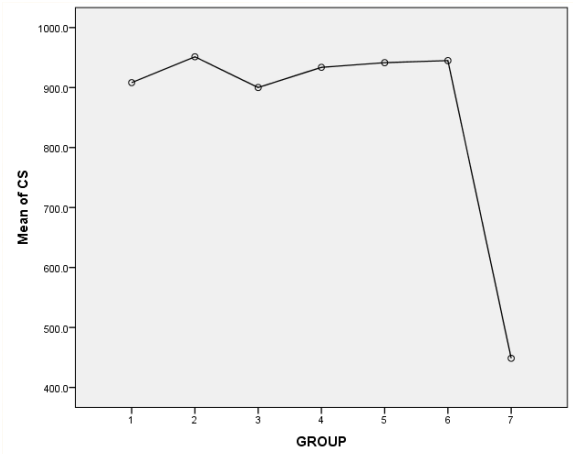
CP -MEAN PLOT

**Table 8 CS Values**

| | CS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 908.176 | 32.791 | 838.000 | 893.700 | 905.000 | 934.700 | 957.000 |
| Group- | 5 | 951.300 | 5.839 | 944.800 | 946.100 | 951.600 | 956.000 | 958.000 |
| Group- | 7 | 900.043 | 86.610 | 703.800 | 926.700 | 932.800 | 934.800 | 938.000 |
| Group- | 10 | 933.740 | 20.766 | 892.300 | 918.700 | 944.400 | 949.400 | 952.600 |
| Group- | 5 | 941.500 | 7.559 | 929.500 | 939.600 | 942.900 | 947.100 | 948.400 |
| Group- | 5 | 944.940 | 18.331 | 924.500 | 925.500 | 955.000 | 958.700 | 961.000 |
| Group- | 5 | 448.620 | 4.504 | 443.600 | 445.200 | 448.200 | 451.500 | 454.600 |
| Total | 62 | 883.450 | 135.692 | 443.600 | 896.300 | 928.100 | 948.400 | 961.000 |



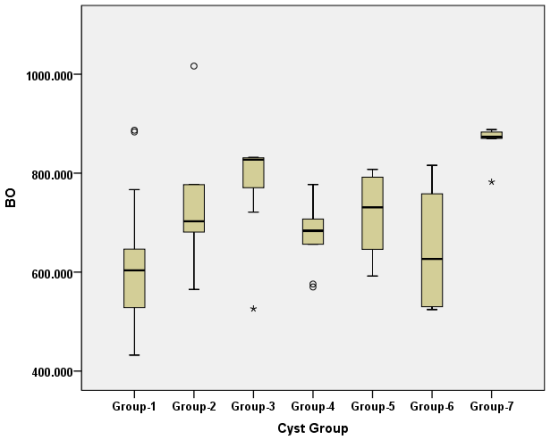

Boxplots of the central region for groups I–VII.

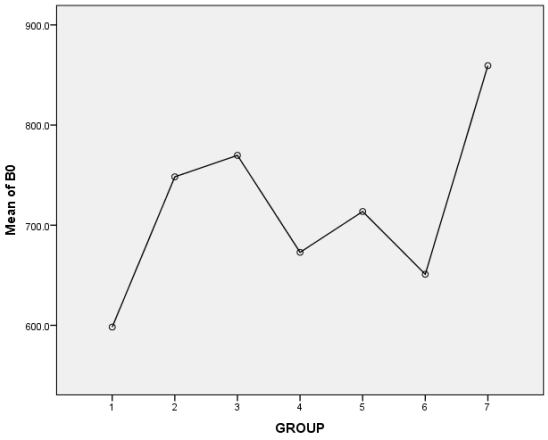



CS -MEAN PLOT

**Table 9 BO Values**

| | BO | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 598.256 | 122.441 | 432.200 | 528.200 | 603.500 | 646.300 | 886.800 |
| Group- | 5 | 748.320 | 168.003 | 565.000 | 680.900 | 702.700 | 776.600 | 1016.400 |
| Group- | 7 | 769.743 | 114.710 | 526.000 | 721.200 | 827.100 | 831.600 | 832.000 |
| Group- | 10 | 672.920 | 63.005 | 570.000 | 656.300 | 683.700 | 707.200 | 776.900 |
| Group- | 5 | 713.680 | 93.019 | 592.000 | 646.000 | 731.000 | 791.800 | 807.600 |
| Group- | 5 | 651.000 | 132.234 | 524.200 | 530.200 | 626.500 | 758.300 | 815.800 |
| Group- | 5 | 859.340 | 43.722 | 782.200 | 870.200 | 873.200 | 883.100 | 888.000 |
| Total | 62 | 676.379 | 135.303 | 432.200 | 570.900 | 669.550 | 782.200 | 1016.400 |



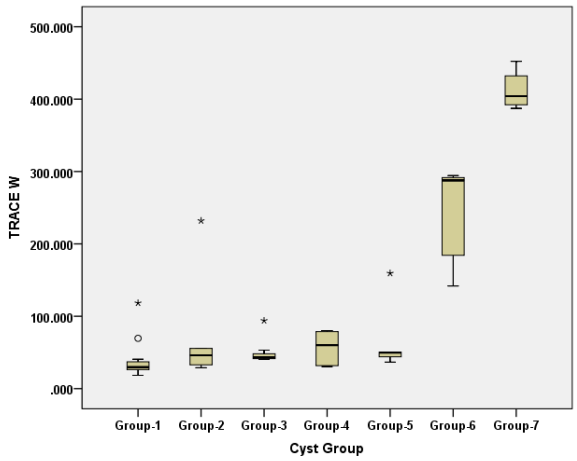




Boxplots of the central region for groups I–VII.

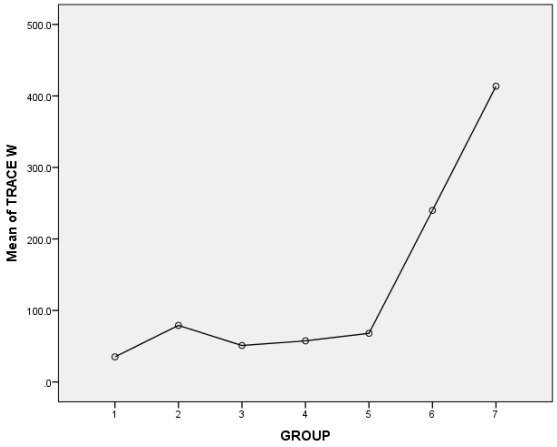
B0 -MEAN PLOT

**Table 10 Trace Values**

| | TRACE W | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | Min | 1st Quartile | Median | 3rd Quartile | Max |
| Group- | 25 | 35.040 | 20.045 | 18.400 | 26.200 | 29.600 | 37.100 | 118.300 |
| Group- | 5 | 79.060 | 86.152 | 28.800 | 32.900 | 46.100 | 55.500 | 232.000 |
| Group- | 7 | 50.957 | 19.466 | 40.500 | 41.200 | 43.100 | 53.200 | 94.000 |
| Group- | 10 | 57.440 | 21.049 | 30.600 | 31.700 | 60.050 | 78.700 | 80.200 |
| Group- | 5 | 68.040 | 51.377 | 36.600 | 43.900 | 49.800 | 50.500 | 159.400 |
| Group- | 5 | 239.940 | 71.858 | 141.800 | 184.200 | 287.700 | 291.600 | 294.400 |
| Group- | 5 | 413.600 | 27.745 | 387.200 | 392.200 | 404.200 | 432.200 | 452.200 |
| Total | 62 | 93.715 | 115.576 | 18.400 | 30.600 | 41.350 | 79.600 | 452.200 |




Boxplots of the central region for groups I–VII.




TRACE W -MEAN PLOT

**Group 1**(developmental cyst) showed mean FA = 0.098, with highest MD of 2.838 x 10(-3) mm(2)/s, RA = 75.008, VR = 983.4, GA = 138.21 & lowest TRACE W = 35.

**Group 2**(acquired cysts) showed lowest FA = 0.05.

**Group 3**(Neurocysticercosis) showed higher mean FA = 0.276 next to that of Epidermoid cyst, higher MD = 2.405 x 10(-3) mm(2)/s, RA = 57.31, VR = 963.186, GA = 95.343.

**Group 4**(low grade tumoral cysts) showed lowest mean FA = 0.084, MD = 2.69 x 10(-3) mm(2)/s.

**Group 5**(high grade tumoral cysts) showed lower mean FA = 0.06, MD = 2.49 x 10(-3) mm(2)/s, RA = 49.4, lower GA =85.6

**Group 6**(Abscess) showed lower mean FA = 0.078, with lowest MD = 0.777 x 10(-3) mm(2)/s, RA = 56.840, VR = 988.88, lowest GA = 78.760.

**Group 7** (Epidermoid cyst) showed mean highest FA = 0.509 , lower MD = 0.866 x 10(-3) mm(2)/s, highest RA = 477.200,lowest VR = 686.200, highest GA = 920, grossly different CL = 218.5, CP =332.920, CS = 448.62, highest B0 =859.34 & highest TRACE W = 413.6 compared to all other cysts.

**PAIRWISE COMPARISON BETWEEN GROUPS ( Mann-Whitney U Test with Bonferroni correction for multiple pair wise comparison)**

| VARIABLE | 1 VERSUS 2 | 1 VERSUS 3 | 1 VERSUS 4 | 1 VERSUS 5 | 1 VERSUS 6 | 1 VERSUS 7 |
|---|---|---|---|---|---|---|
| FA | 0.009 | 0.002 | 0.342 | 0.021 | 0.200 | 0.001 |
| MD | 0.303 | 0.027 | 0.159 | 0.079 | 0.001 | 0.000 |
| RA | 0.004 | 0.186 | 0.235 | 0.042 | 0.156 | 0.001 |
| VR | 0.005 | 0.047 | 0.547 | 0.011 | 0.436 | 0.001 |
| GA | 0.048 | 0.001 | 0.013 | 0.002 | 0.002 | 0.001 |
| CL | 0.011 | 0.274 | 0.121 | 0.037 | 0.008 | 0.001 |
| CP | 0.009 | 0.284 | 0.019 | 0.055 | 0.048 | 0.001 |
| CS | 0.008 | 0.284 | 0.045 | 0.048 | 0.010 | 0.001 |
| BO | 0.032 | 0.011 | 0.019 | 0.055 | 0.487 | 0.002 |
| TRACE W | 0.042 | 0.001 | 0.003 | 0.006 | 0.001 | 0.001 |

Yellow colour boxes – indicates P value is statistically significant < .05

**Mann-Whitney U Test with Bonferroni correction for multiple pair wise comparison**

| VARIABLE | 2 VERSUS 3 | 2 VERSUS 4 | 2 VERSUS 5 | 2 VERSUS 6 | 2 VERSUS 7 |
|---|---|---|---|---|---|
| FA | 0.004 | 0.007 | 0.402 | 0.076 | 0.009 |
| MD | 0.255 | 0.624 | 0.347 | 0.016 | 0.016 |
| RA | 0.004 | 0.007 | 0.028 | 0.047 | 0.009 |
| VR | 0.004 | 0.023 | 0.293 | 0.059 | 0.009 |
| GA | 0.291 | 0.540 | 0.917 | 0.602 | 0.009 |
| CL | 0.004 | 0.012 | 0.209 | 0.602 | 0.009 |
| CP | 0.019 | 0.327 | 0.076 | 0.347 | 0.009 |
| CS | 0.004 | 0.086 | 0.076 | 0.917 | 0.009 |
| BO | 0.372 | 0.462 | 0.917 | 0.347 | 0.117 |
| TRACE W | 0.935 | 0.540 | 0.754 | 0.028 | 0.009 |

Yellow colour boxes – indicates P value is statistically significant < .05

**Mann-Whitney U Test with Bonferroni correction for multiple pair wise comparison**

| VARIABLE | 3 VERSUS 4 | 3 VERSUS 5 | 3 VERSUS 6 | 3 VERSUS 7 |
|---|---|---|---|---|
| FA | 0.002 | 0.004 | 0.006 | 0.042 |
| MD | 0.143 | 0.685 | 0.007 | 0.004 |
| RA | 0.558 | 0.034 | 0.291 | 0.004 |
| VR | 0.064 | 0.004 | 0.123 | 0.004 |
| GA | 0.845 | 0.062 | 0.088 | 0.004 |
| CL | 0.380 | 0.012 | 0.123 | 0.004 |
| CP | 0.118 | 0.255 | 0.193 | 0.004 |
| CS | 0.283 | 0.042 | 0.372 | 0.004 |
| BO | 0.019 | 0.123 | 0.062 | 0.042 |
| TRACE W | 0.558 | 0.465 | 0.004 | 0.004 |

Yellow colour boxes – indicates P value is statistically significant < .05

**Mann-Whitney U Test with Bonferroni correction for multiple pair wise comparison**

| VARIABLE | 4 VERSUS 5 | 4 VERSUS 6 | 4 VERSUS 7 | 5 VERSUS 6 | 5 VERSUS 7 | 6 VERSUS 7 |
|---|---|---|---|---|---|---|
| FA | 0.014 | 0.581 | 0.002 | 0.117 | 0.009 | 0.009 |
| MD | 0.624 | 0.002 | 0.002 | 0.016 | 0.009 | 0.117 |
| RA | 0.050 | 0.624 | 0.002 | 0.117 | 0.009 | 0.009 |
| VR | 0.066 | 0.581 | 0.002 | 0.117 | 0.009 | 0.009 |
| GA | 0.178 | 0.050 | 0.002 | 0.347 | 0.009 | 0.009 |
| CL | 0.142 | 0.111 | 0.002 | 0.602 | 0.009 | 0.009 |
| CP | 0.624 | 0.713 | 0.002 | 0.754 | 0.009 | 0.009 |
| CS | 0.999 | 0.111 | 0.002 | 0.602 | 0.009 | 0.009 |
| BO | 0.327 | 0.624 | 0.002 | 0.465 | 0.028 | 0.016 |
| TRACE W | 0.903 | 0.002 | 0.002 | 0.016 | 0.009 | 0.009 |

Yellow colour boxes – indicates P value is statistically significant < .05

**PAIRWISE COMPARISON BETWEEN GROUPS:**

Comparing group1(developmental cysts) to group 2(acquired cysts)all the DTI parameters except MD show a statistically significant P value of < 0.05 implying that the difference between the groups is significant & not merely by chance. Comparing group1(developmental cysts) to group 3(Neurocysticercosis) 6 of the parameters FA, MD, VR, GA, BO & TRACE W all show a statistically significant difference. Comparing group1(developmental cysts) to group 4( low grade tumours) GA, CP, CS B0, TRACE W show a statistically significant difference. Comparing group1(developmental cysts) to group 5 (high grade tumours) FA, RA, VR, GA, CL, CS&TRACE W show a statistically significant difference. Comparing group1(developmental cysts) to group 6( abcesses) all parameters except FA, RA & VR show a statistically significant difference. Comparing group1(developmental cysts) to group 7( Epidermoid) all the 10 DTI parameters show a statistically significant difference of P value < 0.05.

Comparing group2(acquired cysts) to group3(Neurocysticercosis) FA, RA, VR & all 3 geometric tensors show a statistically significant difference of P value < 0.05. Comparing group2(acquired cysts) to group 4( low grade tumours) FA, RA VR, CL & CS shows a statistically significant difference. Comparing group2(acquired cysts) to group5 (high grade tumours) only RA show a statistically significant difference. Comparing group2(acquired cysts) to group 6( abcesses) only 3 parameters, MD,RA & TRACE W show a statistically significant difference of P value < 0.05. Comparing group2(acquired cysts) to

group 7( Epidermoid) all the DTI parameters except for B0 show a statistically significant difference of P value < 0.05.

Comparing group3(Neurocysticercosis) to group 4( low grade tumours) only FA & BO, & Comparing to group5 (high grade tumours) FA, RA, VR, CL & CS B0 show a statistically significant difference of P value < 0.05. Comparing group3(Neurocysticercosis) to group 6(abcesses) only 3 of the parameters FA, MD & TRACE W shows a statistically significant difference. However comparing to group 7( Epidermoid) all the DTI parameters show a statistically significant difference of P value < 0.05.

Comparing group4( low grade tumours) to group5 (high grade tumours) only FA & RA & comparing to group 6(abcesses) MD, GA,& TRACE W were statistically significant. However Comparing group4( low grade tumours) comparing to group 7( Epidermoid) all the DTI parameters show a statistically significant difference of P value < 0.05.

Comparing group5(high grade tumours) to group 6(abcesses) only MD & TRACE W were statistically significant. Comparing group5(high grade tumours) to group 7( Epidermoid) all the DTI parameters show a statistically significant difference of P value < 0.05. Comparing group6(abcesses) to group 7( Epidermoid) all the DTI parameters except MD show a statistically significant difference of P value < 0.05.

Hence by all these we can clearly infer that epidermoid cysts stands out separate from all other groups.

**Mann-Whitney Test**

| Variables | Cyst group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-1 | 25 | 31.74 | 0.931 |
| | Others | 37 | 31.34 | |
| MD | Group-1 | 25 | 41.94 | <0.001 |
| | Others | 37 | 24.45 | |
| RA | Group-1 | 25 | 36.00 | 0.106 |
| | Others | 37 | 28.46 | |
| VR | Group-1 | 25 | 30.66 | 0.763 |
| | Others | 37 | 32.07 | |
| GA | Group-1 | 25 | 40.44 | 0.001 |
| | Others | 37 | 25.46 | |
| CL | Group-1 | 25 | 36.88 | 0.054 |
| | Others | 37 | 27.86 | |
| CP | Group-1 | 25 | 37.18 | 0.042 |
| | Others | 37 | 27.66 | |
| CS | Group-1 | 25 | 25.68 | 0.037 |
| | Others | 37 | 35.43 | |
| BO | Group-1 | 25 | 21.12 | <0.001 |
| | Others | 37 | 38.51 | |
| TRACE W | Group-1 | 25 | 16.84 | <0.001 |
| | Others | 37 | 41.41 | |

**Mann-Whitney Test**

| Variables | Cyst group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-2 | 5 | 9.20 | 0.004 |
| | Others | 57 | 33.46 | |
| MD | Group-2 | 5 | 35.50 | 0.605 |
| | Others | 57 | 31.15 | |
| RA | Group-2 | 5 | 6.80 | 0.001 |
| | Others | 57 | 33.67 | |
| VR | Group-2 | 5 | 54.20 | 0.003 |
| | Others | 57 | 29.51 | |
| GA | Group-2 | 5 | 20.20 | 0.144 |
| | Others | 57 | 32.49 | |
| CL | Group-2 | 5 | 11.60 | 0.010 |
| | Others | 57 | 33.25 | |
| CP | Group-2 | 5 | 12.50 | 0.014 |
| | Others | 57 | 33.17 | |
| CS | Group-2 | 5 | 51.40 | 0.010 |
| | Others | 57 | 29.75 | |
| BO | Group-2 | 5 | 38.60 | 0.359 |
| | Others | 57 | 30.88 | |
| TRACE W | Group-2 | 5 | 33.00 | 0.846 |
| | Others | 57 | 31.37 | |

**Mann-Whitney Test**

| Variables | Cyst group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-3 | 7 | 51.57 | 0.002 |
| | Others | 55 | 28.95 | |
| MD | Group-3 | 7 | 25.93 | 0.386 |
| | Others | 55 | 32.21 | |
| RA | Group-3 | 7 | 27.43 | 0.526 |
| | Others | 55 | 32.02 | |
| VR | Group-3 | 7 | 18.71 | 0.046 |
| | Others | 55 | 33.13 | |
| GA | Group-3 | 7 | 22.57 | 0.164 |
| | Others | 55 | 32.64 | |
| CL | Group-3 | 7 | 32.93 | 0.824 |
| | Others | 55 | 31.32 | |
| CP | Group-3 | 7 | 32.14 | 0.920 |
| | Others | 55 | 31.42 | |
| CS | Group-3 | 7 | 30.71 | 0.903 |
| | Others | 55 | 31.60 | |
| BO | Group-3 | 7 | 44.86 | 0.038 |
| | Others | 55 | 29.80 | |
| TRACE W | Group-3 | 7 | 35.43 | 0.541 |
| | Others | 55 | 31.00 | |

**Mann-Whitney Test**

| Variables | Cyst group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-4 | 10 | 27.85 | 0.485 |
| | Others | 52 | 32.20 | |
| MD | Group-4 | 10 | 34.15 | 0.612 |
| | Others | 52 | 30.99 | |
| RA | Group-4 | 10 | 30.55 | 0.856 |
| | Others | 52 | 31.68 | |
| VR | Group-4 | 10 | 33.75 | 0.667 |
| | Others | 52 | 31.07 | |
| GA | Group-4 | 10 | 25.60 | 0.259 |
| | Others | 52 | 32.63 | |
| CL | Group-4 | 10 | 28.40 | 0.553 |
| | Others | 52 | 32.10 | |
| CP | Group-4 | 10 | 21.10 | 0.047 |
| | Others | 52 | 33.50 | |
| CS | Group-4 | 10 | 37.90 | 0.221 |
| | Others | 52 | 30.27 | |
| BO | Group-4 | 10 | 32.00 | 0.924 |
| | Others | 52 | 31.40 | |
| TRACE W | Group-4 | 10 | 35.90 | 0.400 |
| | Others | 52 | 30.65 | |

**Mann-Whitney Test**

| Variables | Cyst group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-5 | 5 | 12.50 | 0.014 |
| | Others | 57 | 33.17 | |
| MD | Group-5 | 5 | 28.80 | 0.727 |
| | Others | 57 | 31.74 | |
| RA | Group-5 | 5 | 16.50 | 0.052 |
| | Others | 57 | 32.82 | |
| VR | Group-5 | 5 | 50.10 | 0.016 |
| | Others | 57 | 29.87 | |
| GA | Group-5 | 5 | 14.20 | 0.025 |
| | Others | 57 | 33.02 | |
| CL | Group-5 | 5 | 17.70 | 0.074 |
| | Others | 57 | 32.71 | |
| CP | Group-5 | 5 | 23.50 | 0.301 |
| | Others | 57 | 32.20 | |
| CS | Group-5 | 5 | 41.40 | 0.201 |
| | Others | 57 | 30.63 | |
| BO | Group-5 | 5 | 36.80 | 0.493 |
| | Others | 57 | 31.04 | |
| TRACE W | Group-5 | 5 | 37.60 | 0.430 |
| | Others | 57 | 30.96 | |

**Mann-Whitney Test**

| Variables | Cyst group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-6 | 5 | 23.30 | 0.289 |
| | Others | 57 | 32.22 | |
| MD | Group-6 | 5 | 4.80 | 0.001 |
| | Others | 57 | 33.84 | |
| RA | Group-6 | 5 | 27.80 | 0.632 |
| | Others | 57 | 31.82 | |
| VR | Group-6 | 5 | 36.30 | 0.535 |
| | Others | 57 | 31.08 | |
| GA | Group-6 | 5 | 11.20 | 0.009 |
| | Others | 57 | 33.28 | |
| CL | Group-6 | 5 | 14.00 | 0.024 |
| | Others | 57 | 33.04 | |
| CP | Group-6 | 5 | 21.50 | 0.196 |
| | Others | 57 | 32.38 | |
| CS | Group-6 | 5 | 47.60 | 0.037 |
| | Others | 57 | 30.09 | |
| BO | Group-6 | 5 | 27.00 | 0.561 |
| | Others | 57 | 31.89 | |
| TRACE W | Group-6 | 5 | 54.40 | 0.003 |
| | Others | 57 | 29.49 | |

**Mann-Whitney Test**

| Variables | Cyst group | N | Mean Rank | P-Value |
|---|---|---|---|---|
| FA | Group-7 | 5 | 59.00 | <0.001 |
| | Others | 57 | 29.09 | |
| MD | Group-7 | 5 | 7.20 | 0.002 |
| | Others | 57 | 33.63 | |
| RA | Group-7 | 5 | 60.00 | <0.001 |
| | Others | 57 | 29.00 | |
| VR | Group-7 | 5 | 3.00 | <0.001 |
| | Others | 57 | 34.00 | |
| GA | Group-7 | 5 | 60.00 | <0.001 |
| | Others | 57 | 29.00 | |
| CL | Group-7 | 5 | 60.00 | <0.001 |
| | Others | 57 | 29.00 | |
| CP | Group-7 | 5 | 60.00 | <0.001 |
| | Others | 57 | 29.00 | |
| CS | Group-7 | 5 | 3.00 | <0.001 |
| | Others | 57 | 34.00 | |
| BO | Group-7 | 5 | 55.80 | 0.002 |
| | Others | 57 | 29.37 | |
| TRACE W | Group-7 | 5 | 60.00 | <0.001 |
| | Others | 57 | 29.00 | |

**DTI PARAMETER IN ONE GROUP VERSUS OTHER GROUPS**

**(Mann-Whitney U Test with Bonferroni correction for multiple pair wise comparison)**

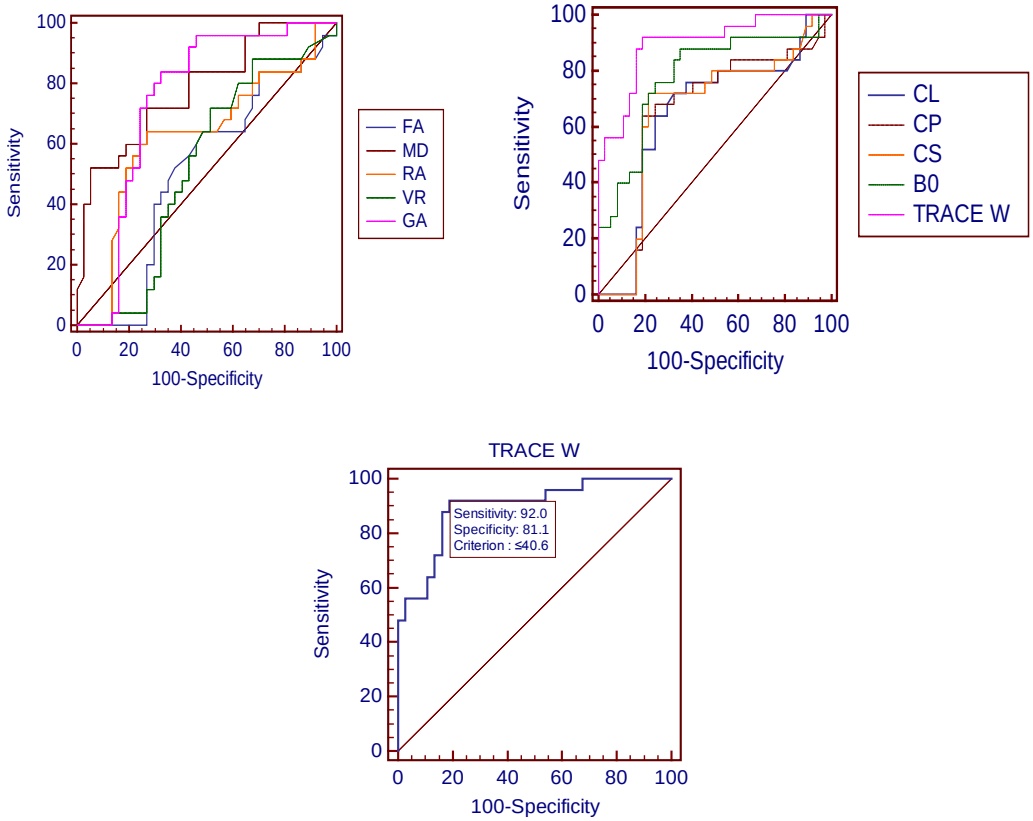
| | GROUP-1 VS REST | GROUP-2 VS REST | GROUP-3 VS REST | GROUP-4 VS REST | GROUP-5 VS REST | GROUP-6 VS REST | GROUP-7 VS REST |
|---|---|---|---|---|---|---|---|
| FA | 0.931 | 0.004 | 0.002 | 0.485 | 0.014 | 0.289 | <0.001 |
| MD | 0.001 | 0.605 | 0.386 | 0.612 | 0.727 | 0.001 | 0.002 |
| RA | 0.106 | 0.001 | 0.526 | 0.856 | 0.052 | 0.632 | <0.001 |
| VR | 0.763 | 0.003 | 0.046 | 0.667 | 0.016 | 0.535 | <0.001 |
| GA | 0.001 | 0.144 | 0.164 | 0.259 | 0.025 | 0.009 | <0.001 |
| CL | 0.054 | 0.010 | 0.824 | 0.553 | 0.074 | 0.024 | <0.001 |
| CP | 0.042 | 0.014 | 0.920 | 0.047 | 0.301 | 0.196 | <0.001 |
| CS | 0.037 | 0.010 | 0.903 | 0.221 | 0.201 | 0.037 | <0.001 |
| BO | <0.001 | 0.359 | 0.038 | 0.924 | 0.493 | 0.561 | 0.002 |
| TRACE | <0.001 | 0.846 | 0.541 | 0.400 | 0.430 | 0.003 | <0.001 |

*. The P value is significant < 0.05 level Mann-Whitney test;.(yellow coloured boxes)

The DTI parameters like MD, GA, CP, CS, B0 & TRACE W help us differentiating developmental cysts from all other group of cysts. FA, RA, VR & geometric tensors differentiates acquired cysts from the rest. FA, VR & B0 differentiates Neurocysticercosis cysts from the rest. CP & TRACE W differentiates low grade tumours from others. FA, VR & GA differentiates high grade tumours from others. Similarly MD, CL, CS & TRACE W differentiates

abcesses from other cystic lesions. All 10 DTI parameters clearly delineates Epidermoid from all other cysts.

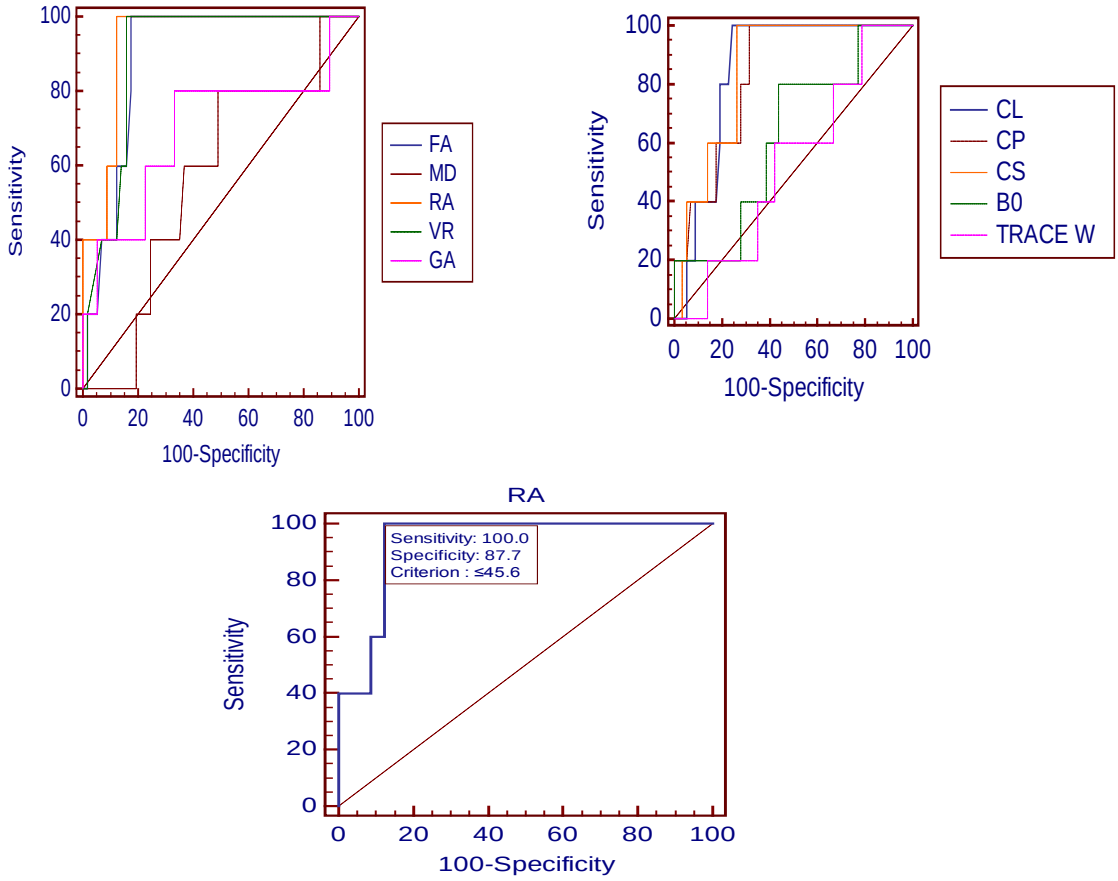
**ROC CURVE OF DTI PARAMETERS IN GROUP 1 VERSES OTHER GROUPS**




**Area under the ROC curve (AUC)**

| | |
|---|---|
| Area under the ROC curve (AUC) | 0.896216 |
| Standard Error[a] | 0.0414 |
| 95% Confidence interval[b] | 0.792395 to 0.959257 |
| Significance level P (Area=0.5) | <0.0001 |

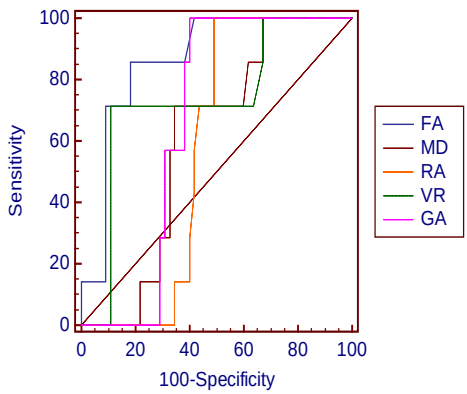
**ROC CURVE OF DTI PARAMETERS IN GROUP 2 VERSES OTHER GROUPS**

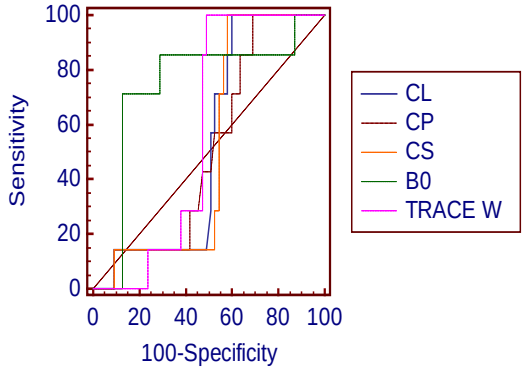


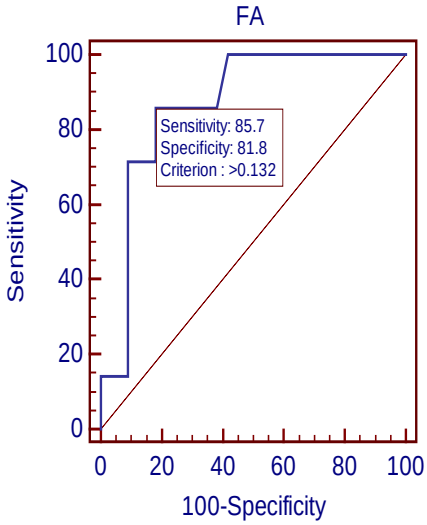

**Area under the ROC curve (AUC)**

| | |
|---|---|
| Area under the ROC curve (AUC) | 0.933333 |
| Standard Error[a] | 0.0370 |
| 95% Confidence interval[b] | 0.840099 to 0.981018 |
| Significance level P (Area=0.5) | <0.0001 |

## ROC CURVE OF DTI PARAMETERS IN GROUP 3 VERSES OTHER GROUPS



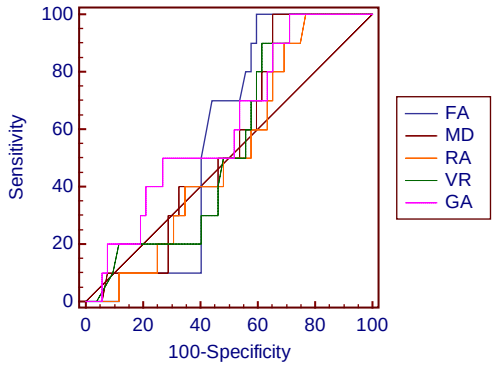



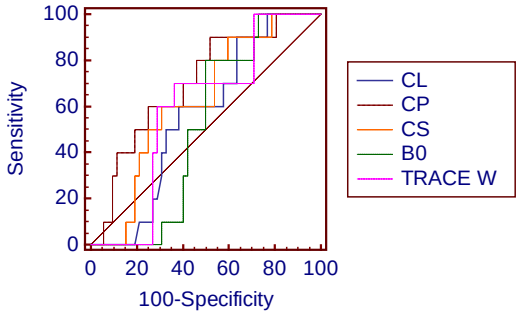



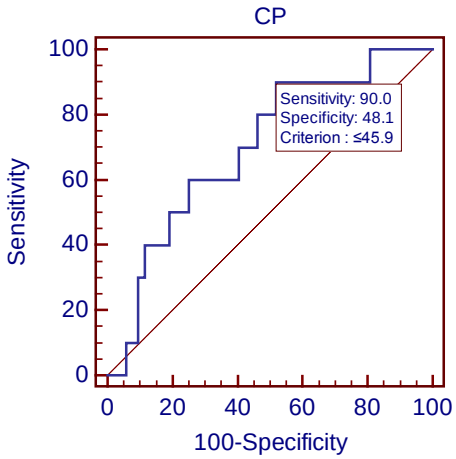

### Area under the ROC curve (AUC)

| | |
|---|---|
| Area under the ROC curve (AUC) | 0.864935 |
| Standard Error[a] | 0.0588 |
| 95% Confidence interval[b] | 0.754251 to 0.938468 |
| Significance level P (Area=0.5) | <0.0001 |

## ROC CURVE OF DTI PARAMETERS IN GROUP 4 VERSES OTHER GROUPS



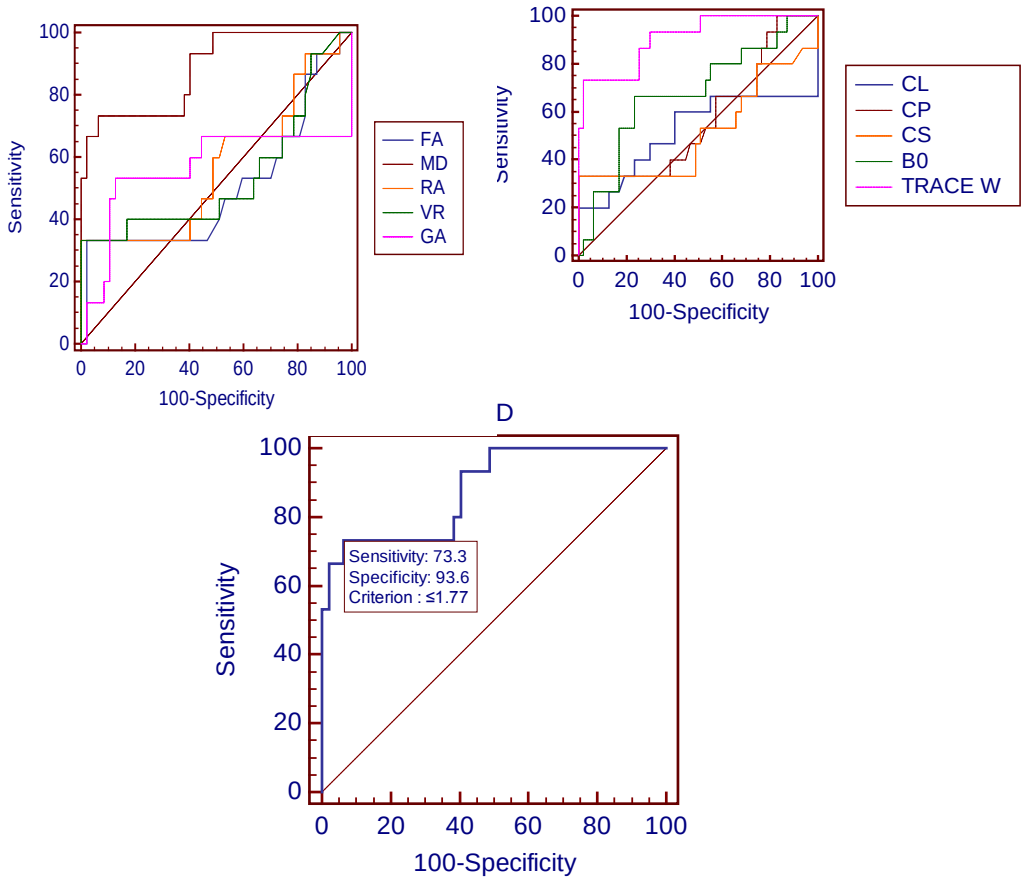




### Area under the ROC curve (AUC)

| | |
|---|---|
| Area under the ROC curve (AUC) | 0.700000 |
| Standard Error[a] | 0.0871 |
| 95% Confidence interval[b] | 0.570283 to 0.809854 |
| Significance level P (Area=0.5) | 0.0217 |

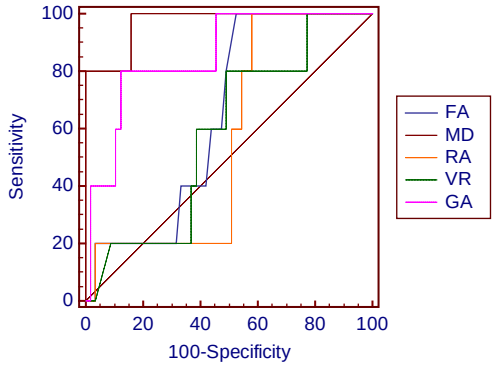
## ROC CURVE OF DTI PARAMETERS IN GROUP 5 VERSES OTHER GROUPS

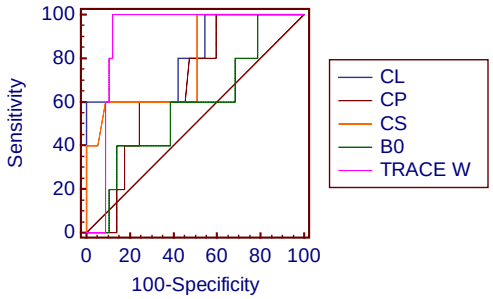


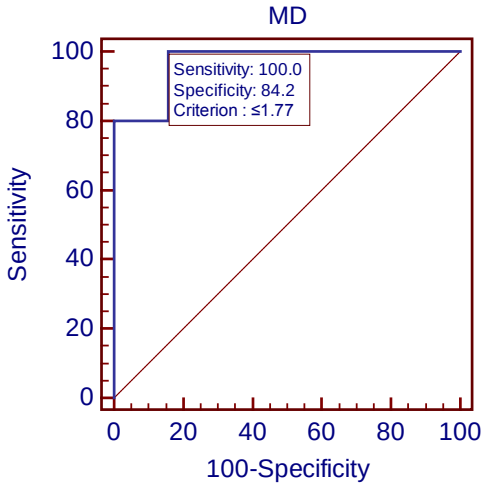

### Area under the ROC curve (AUC)

| | |
|---|---|
| Area under the ROC curve (AUC) | 0.880851 |
| Standard Error[a] | 0.0531 |
| 95% Confidence interval[b] | 0.773467 to 0.949267 |
| Significance level P (Area=0.5) | <0.0001 |

## ROC CURVE OF DTI PARAMETERS IN GROUP 6 VERSES OTHER GROUPS



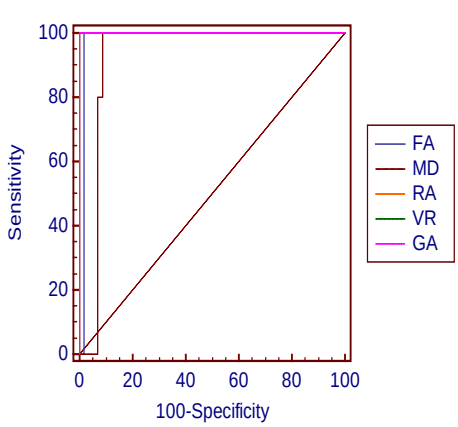



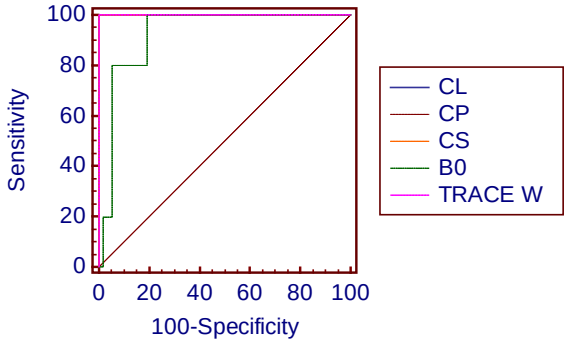




### Area under the ROC curve (AUC)

| | |
|---|---|
| Area under the ROC curve (AUC) | 0.968421 |
| Standard Error[a] | 0.0330 |
| 95% Confidence interval[b] | 0.889293 to 0.996281 |
| Significance level P (Area=0.5) | <0.0001 |

**ROC CURVE OF DTI PARAMETERS IN GROUP 7 VERSES OTHERS**



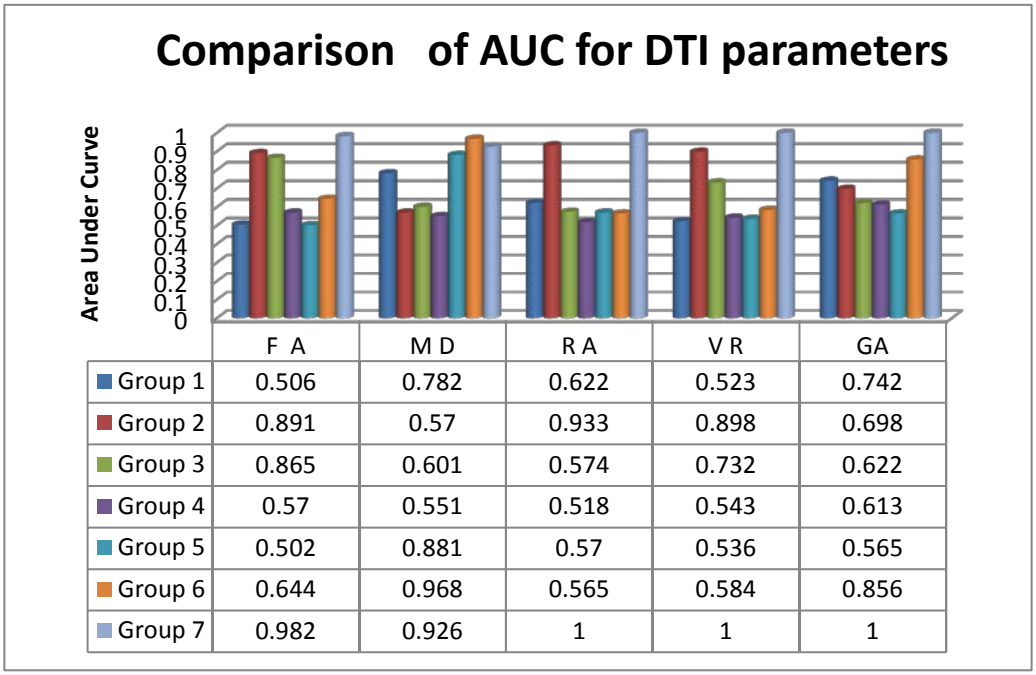




All the DTI parameters show statistically significant P values and AUC in group 7

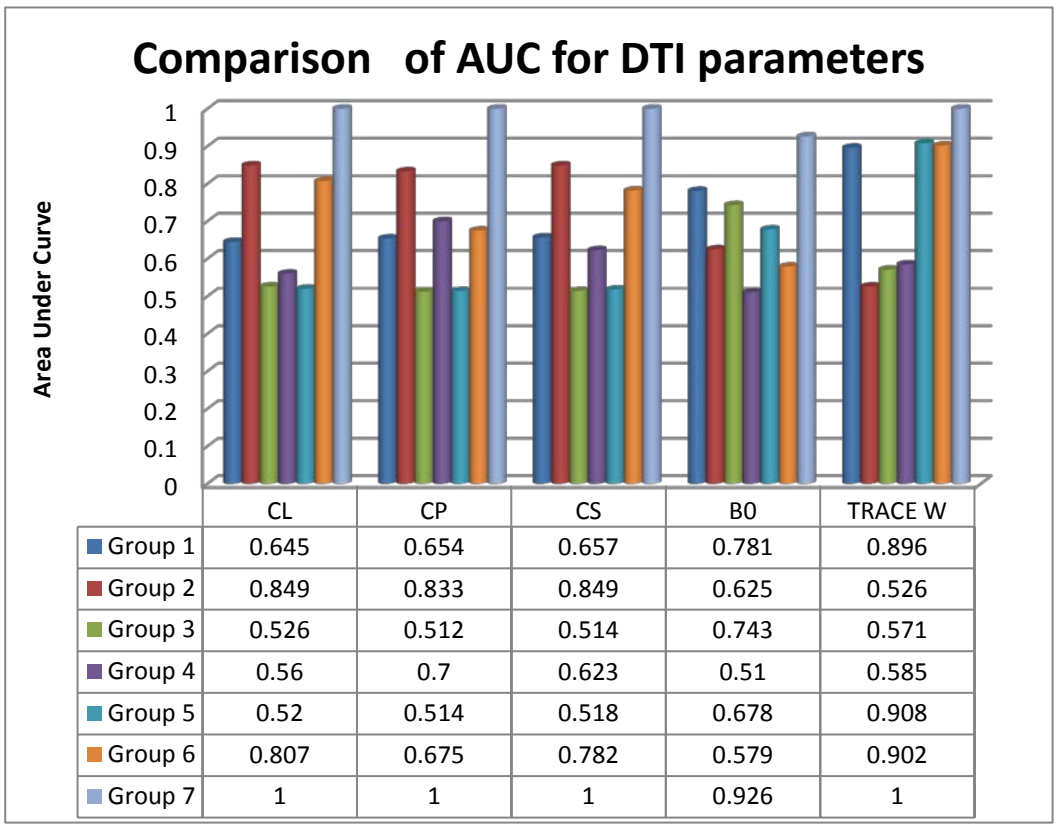
**Area under the ROC curve (AUC)**

In group 1 (developmental cysts) the parameter TRACE W has the highest diagnostic accuracy showing AUC of 0.8, sensitivity of 92% & specificity of 81%. In group 2 (acquired cysts) the parameter RA has the highest diagnostic accuracy showing AUC of 0.9, sensitivity of 100% & specificity of 88%. In group 3 (Neurocysticercosis) the parameter FA has the highest diagnostic accuracy showing AUC of 0.86, sensitivity of 85.7% & specificity of 81.8%. In group 4 ( low grade tumours) the parameter CP has the highest diagnostic accuracy showing AUC of 0.7, sensitivity of 90% & specificity of 48%. In group 5 ( high grade tumours) the parameter MD has the highest diagnostic accuracy showing AUC of 0.8, sensitivity of 73% & specificity of 93.6%. In group 6 ( abcesses) the parameter MD has the highest diagnostic accuracy showing AUC of 0.9, sensitivity of 100% & specificity of

84.2%. In group 7 (Epidermoid) all the parameters showed a very good diagnostic accuracy showing AUC =1, sensitivity of 100% & specificity of 100%.




| | F A | M D | R A | V R | GA |
|---|---|---|---|---|---|
| Group 1 | 0.506 | 0.782 | 0.622 | 0.523 | 0.742 |
| Group 2 | 0.891 | 0.57 | 0.933 | 0.898 | 0.698 |
| Group 3 | 0.865 | 0.601 | 0.574 | 0.732 | 0.622 |
| Group 4 | 0.57 | 0.551 | 0.518 | 0.543 | 0.613 |
| Group 5 | 0.502 | 0.881 | 0.57 | 0.536 | 0.565 |
| Group 6 | 0.644 | 0.968 | 0.565 | 0.584 | 0.856 |
| Group 7 | 0.982 | 0.926 | 1 | 1 | 1 |




| | CL | CP | CS | B0 | TRACE W |
|---|---|---|---|---|---|
| Group 1 | 0.645 | 0.654 | 0.657 | 0.781 | 0.896 |
| Group 2 | 0.849 | 0.833 | 0.849 | 0.625 | 0.526 |
| Group 3 | 0.526 | 0.512 | 0.514 | 0.743 | 0.571 |
| Group 4 | 0.56 | 0.7 | 0.623 | 0.51 | 0.585 |
| Group 5 | 0.52 | 0.514 | 0.518 | 0.678 | 0.908 |
| Group 6 | 0.807 | 0.675 | 0.782 | 0.579 | 0.902 |
| Group 7 | 1 | 1 | 1 | 0.926 | 1 |

| Group | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| FA | 0.506 | 0.891 | 0.865 | 0.57 | 0.502 | 0.644 | 0.982 |
| MD | 0.782 | 0.57 | 0.601 | 0.551 | 0.881 | 0.968 | 0.926 |
| RA | 0.622 | 0.933 | 0.574 | 0.518 | 0.57 | 0.565 | 1 |
| VR | 0.523 | 0.898 | 0.732 | 0.543 | 0.536 | 0.584 | 1 |
| GA | 0.742 | 0.698 | 0.622 | 0.613 | 0.565 | 0.856 | 1 |
| CL | 0.645 | 0.849 | 0.526 | 0.56 | 0.52 | 0.807 | 1 |
| CP | 0.654 | 0.833 | 0.512 | 0.7 | 0.514 | 0.675 | 1 |
| CS | 0.657 | 0.849 | 0.514 | 0.623 | 0.518 | 0.782 | 1 |
| B0 | 0.781 | 0.625 | 0.743 | 0.51 | 0.678 | 0.579 | 0.926 |
| TRACE | 0.896 | 0.526 | 0.571 | 0.585 | 0.908 | 0.902 | 1 |

Significant by area under the curve

## Summarised values of mean of DTI parameter, Mann-Whitney U Test & Area under curve of all groups, high lightening the mean of the DTI parameter with statistically significant P values

| Group | | FA | MD | RA | GA | VR | CL | CP | CS | B0 | TRACE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mean | 0.0984 | 2.8384 | 75.056 | 138.21 | 983.40 | 36.680 | 55.100 | 908.17 | 598.25 | 35.040 |
| | SD | 0.0393 | 0.4303 | 25.640 | 33.061 | 23.518 | 15.265 | 19.995 | 32.791 | 122.44 | 20.045 |
| | MWU | 0.931 | 0.001 | 0.106 | 0.001 | 0.763 | 0.054 | 0.042 | 0.037 | <0.001 | <0.001 |
| | AUC | 0.506 | 0.982 | 0.622 | 0.742 | 0.523 | 0.645 | 0.654 | 0.657 | 0.781 | 0.896 |
| 2 | Mean | 0.0561 | 2.5236 | 41.500 | 102.84 | 996.66 | 17.640 | 31.000 | 951.30 | 748.32 | 79.060 |
| | SD | 0.0094 | 0.9041 | 4.6433 | 50.474 | 0.8532 | 3.104 | 5.008 | 5.838 | 168.00 | 86.152 |
| | MWU | 0.004 | 0.605 | 0.001 | 0.144 | 0.003 | 0.010 | 0.014 | 0.010 | 0.359 | 0.846 |
| | AUC | 0.891 | 0.57 | 0.933 | 0.698 | 0.898 | 0.849 | 0.833 | 0.849 | 0.625 | 0.526 |
| 3 | Mean | 0.154 | 2.4054 | 57.371 | 95.343 | 963.18 | 36.786 | 63.029 | 900.04 | 769.74 | 50.957 |
| | SD | 0.1921 | 0.4102 | 2.0646 | 5.0305 | 21.983 | 27.024 | 59.895 | 86.610 | 114.70 | 19.466 |
| | MWU | 0.002 | 0.386 | 0.526 | 0.164 | 0.046 | 0.824 | 0.920 | 0.903 | 0.038 | 0.541 |
| | AUC | 0.891 | 0.601 | 0.574 | 0.622 | 0.732 | 0.526 | 0.512 | 0.514 | 0.743 | 0.571 |
| 4 | Mean | 0.0842 | 2.6910 | 64.050 | 108.77 | 990.09 | 28.020 | 38.360 | 933.74 | 672.92 | 57.440 |
| | SD | 0.0132 | 0.3147 | 14.516 | 28.612 | 5.5062 | 9.575 | 13.354 | 20.766 | 63.004 | 21.048 |
| | MWU | 0.485 | 0.612 | 0.856 | 0.259 | 0.667 | 0.553 | 0.047 | 0.221 | 0.924 | 0.400 |
| | AUC | 0.57 | 0.57 | 0.518 | 0.613 | 0.543 | 0.56 | 0.7 | 0.623 | 0.51 | 0.585 |
| 5 | Mean | 0.0604 | 2.4984 | 49.400 | 85.600 | 995.86 | 20.820 | 37.600 | 941.50 | 713.68 | 68.040 |
| | SD | 0.0069 | 0.6560 | 5.2536 | 9.1572 | 0.8905 | 2.830 | 5.5403 | 7.5580 | 93.019 | 51.376 |
| | MWU | 0.014 | 0.727 | 0.052 | 0.025 | 0.016 | 0.074 | 0.301 | 0.201 | 0.493 | 0.430 |
| | AUC | 0.502 | 0.881 | 0.57 | 0.565 | 0.536 | 0.52 | 0.514 | 0.518 | 0.678 | 0.908 |
| 6 | Mean | 0.0780 | 0.7774 | 56.840 | 78.760 | 988.88 | 17.640 | 37.440 | 944.94 | 651.00 | 239.940 |
| | SD | 0.0177 | 0.5554 | 10.375 | 19.124 | 10.799 | 10.102 | 8.8410 | 18.331 | 132.23 | 71.857 |
| | MWU | 0.289 | 0.001 | 0.632 | 0.009 | 0.535 | 0.024 | 0.196 | 0.037 | 0.561 | 0.003 |
| | AUC | 0.644 | 0.968 | 0.565 | 0.856 | 0.584 | 0.807 | 0.675 | 0.782 | 0.579 | 0.902 |
| 7 | Mean | 0.5088 | 0.8662 | 477.20 | 920.00 | 686.20 | 218.50 | 332.92 | 448.62 | 859.34 | 413.600 |
| | SD | 0.0768 | 0.1396 | 27.380 | 42.608 | 46.397 | 2.0821 | 5.4300 | 4.5036 | 43.722 | 27.7453 |
| | MWU | <0.001 | 0.002 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.002 | <0.001 |
| | AUC | 0.982 | 0.926 | 1 | 1 | 1 | 1 | 1 | 1 | 0.926 | 1 |

Mann-Whitney U Test ALONE significant below P value < 0.05.
AUC and Mann-Whitney U Test both are significant
AUC alone significant

**ILLUSTRATIVE CASES** **CASE 1**

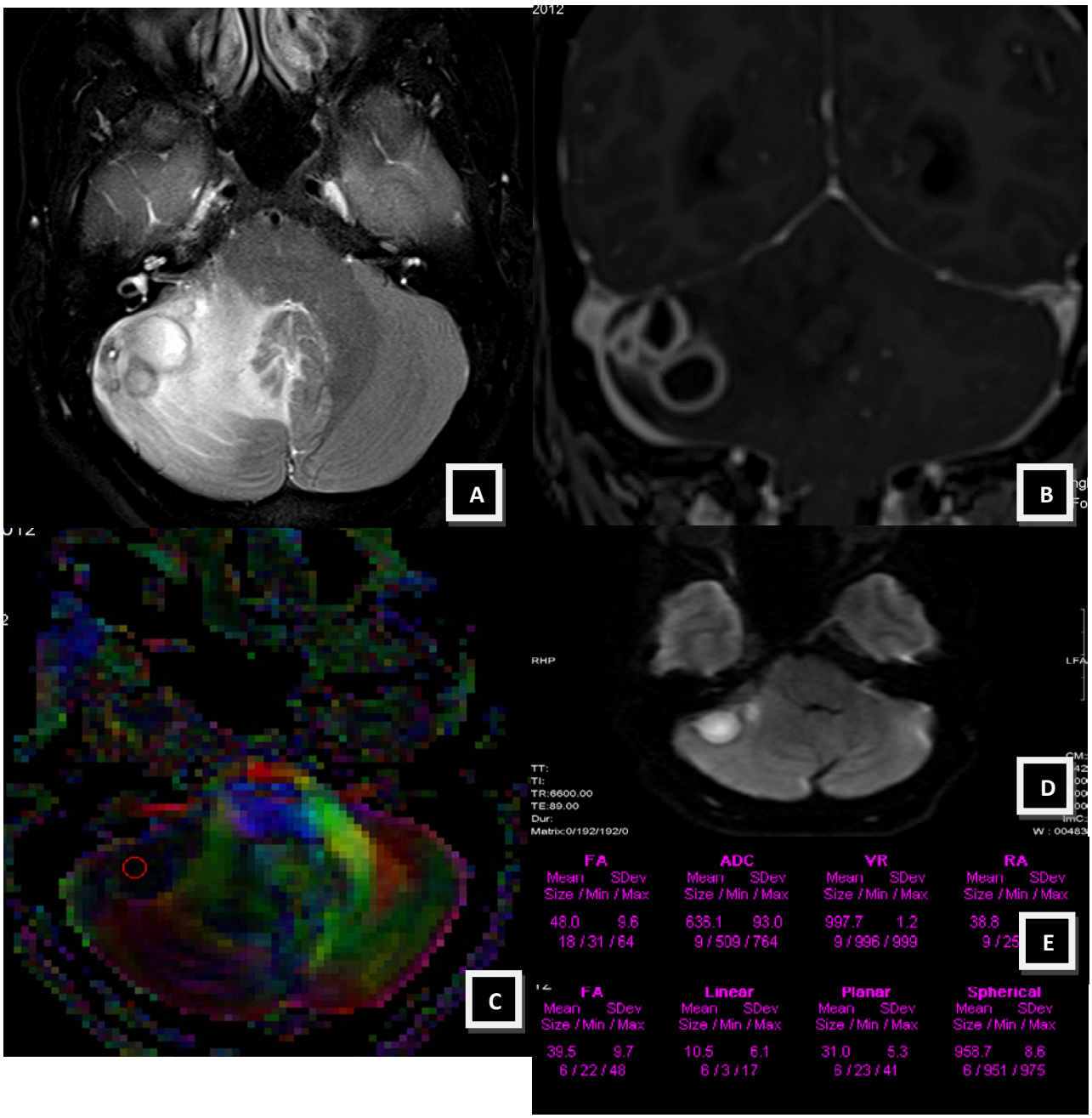



**Fig. 1: Case of right cerebellar abscess**

**A**, T2 weighted MRI shows a multiloculated hyperintense lesion with surrounding edema involving the right cerebellar hemisphere
**B**, T1 FS Contrast MRI shows ring enhancement of the same lesions
**C**, ROI placement
**D,** DWI showing restriction
**E,** Derivation of metrics in the lesion.

## CASE 2

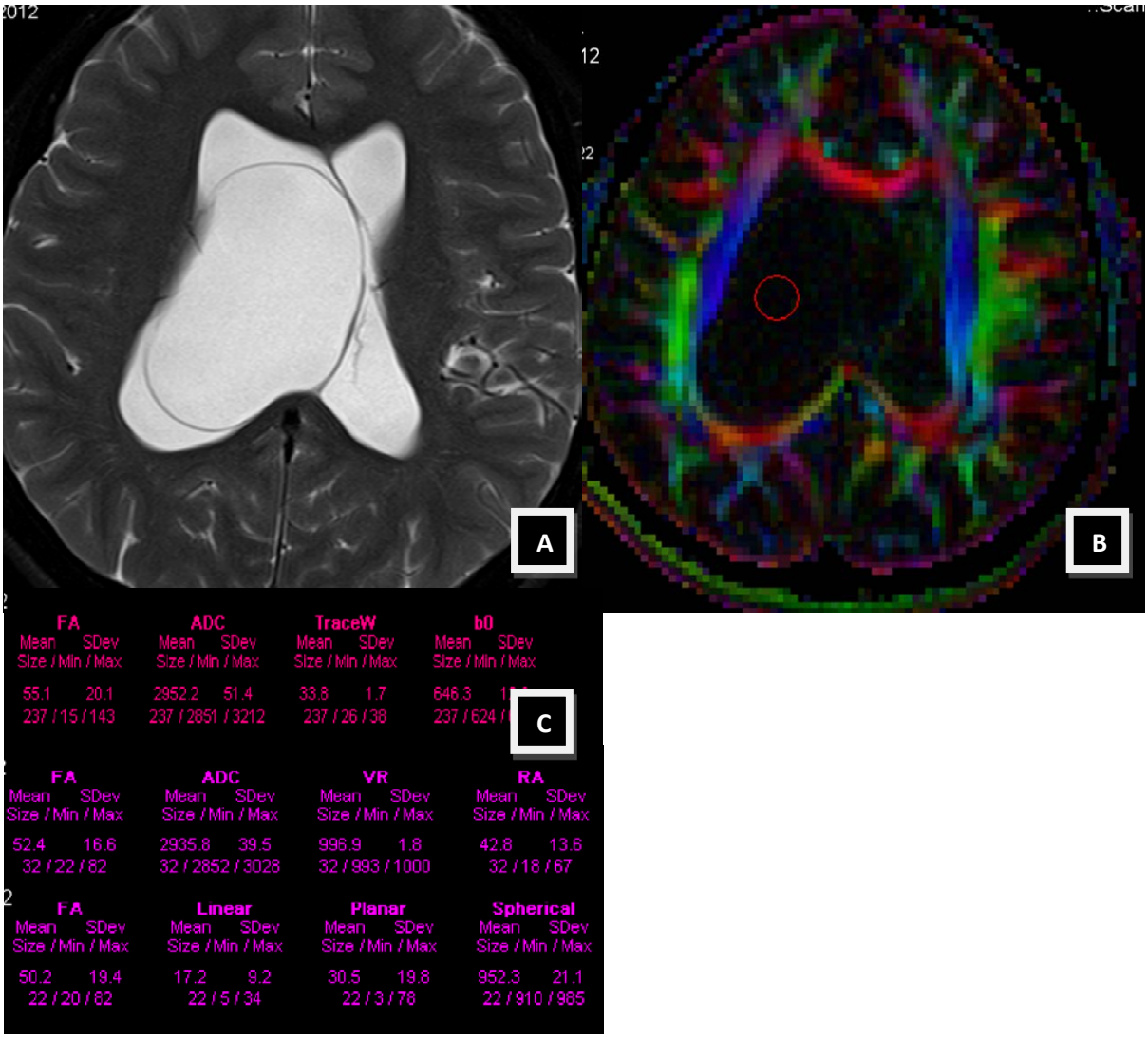



**Fig. 2: Case of intraventricular arachnoid cyst**

**A**, T2 wieghted MRI shows a well circumscribed T2 hyperintense lesion in the body of right lateral ventricle.

**B**, FA map with ROI placement

**C,** Derivation of metrics

## CASE 3

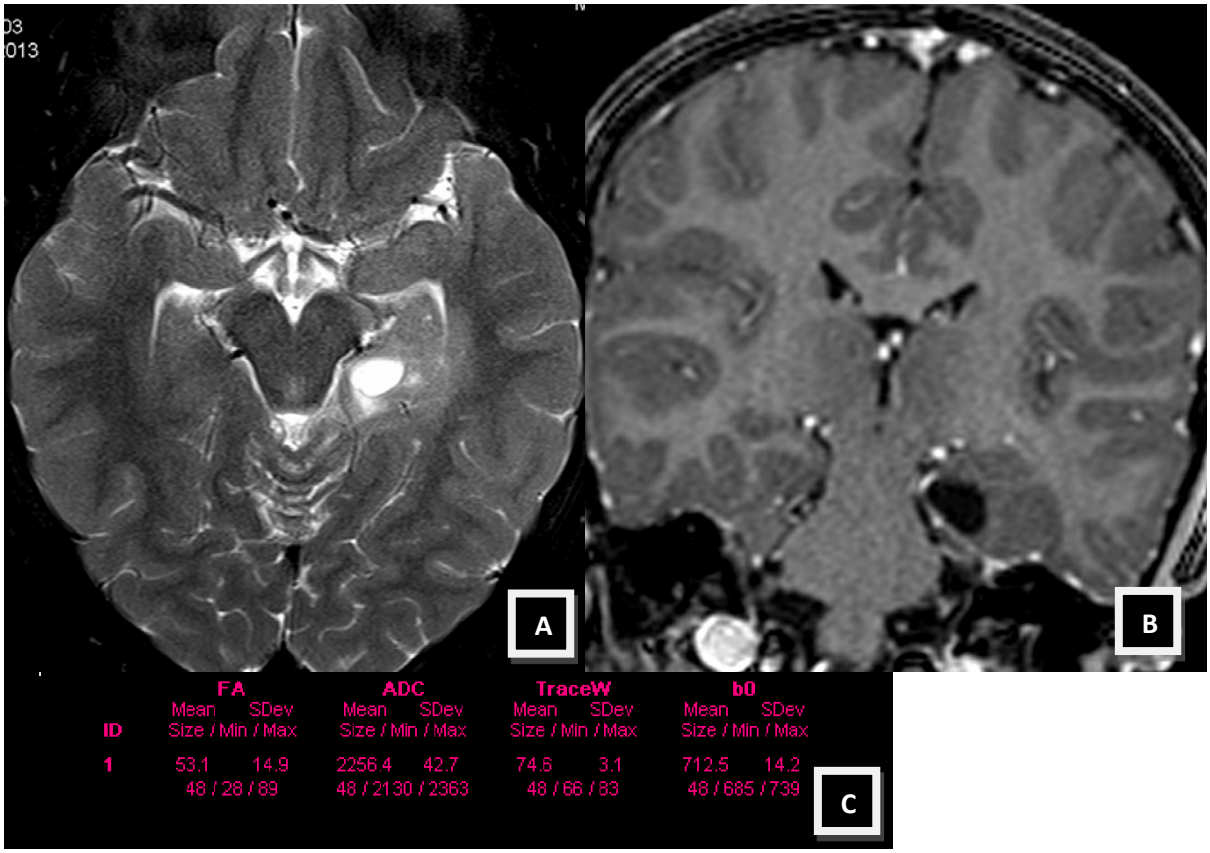



**Fig. 3: Case of DNET**

**A ,** T2 weighted image shows a well-defined hyperintense lesion in left medial temporal lobe

**B**, T1 contrast shows no enhancement of the lesion

## CASE 4

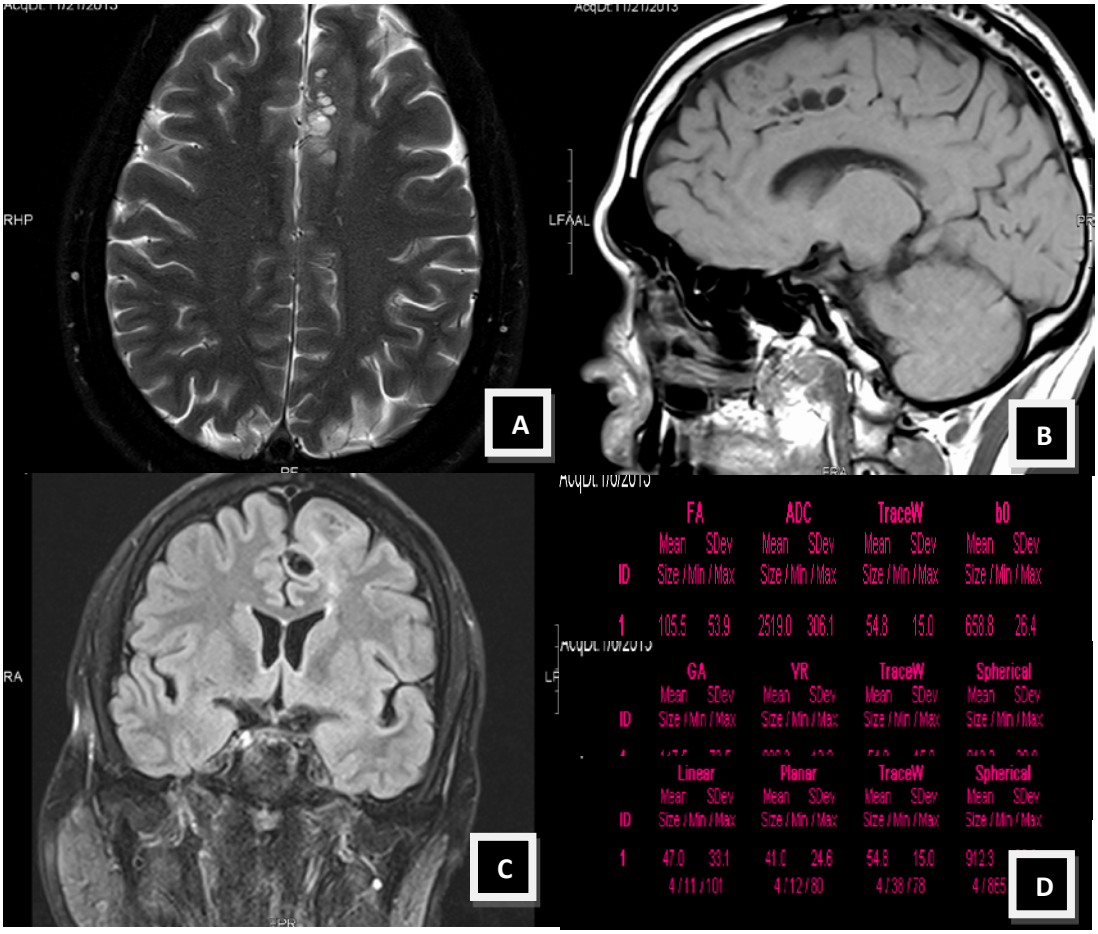



**Fig. 4: Case of DNET**

**A, B** - Axial T2, Sagittal T1images

**C, D** - T2flair Coronal,

**E -** DTI metrics images.

## CASE 5

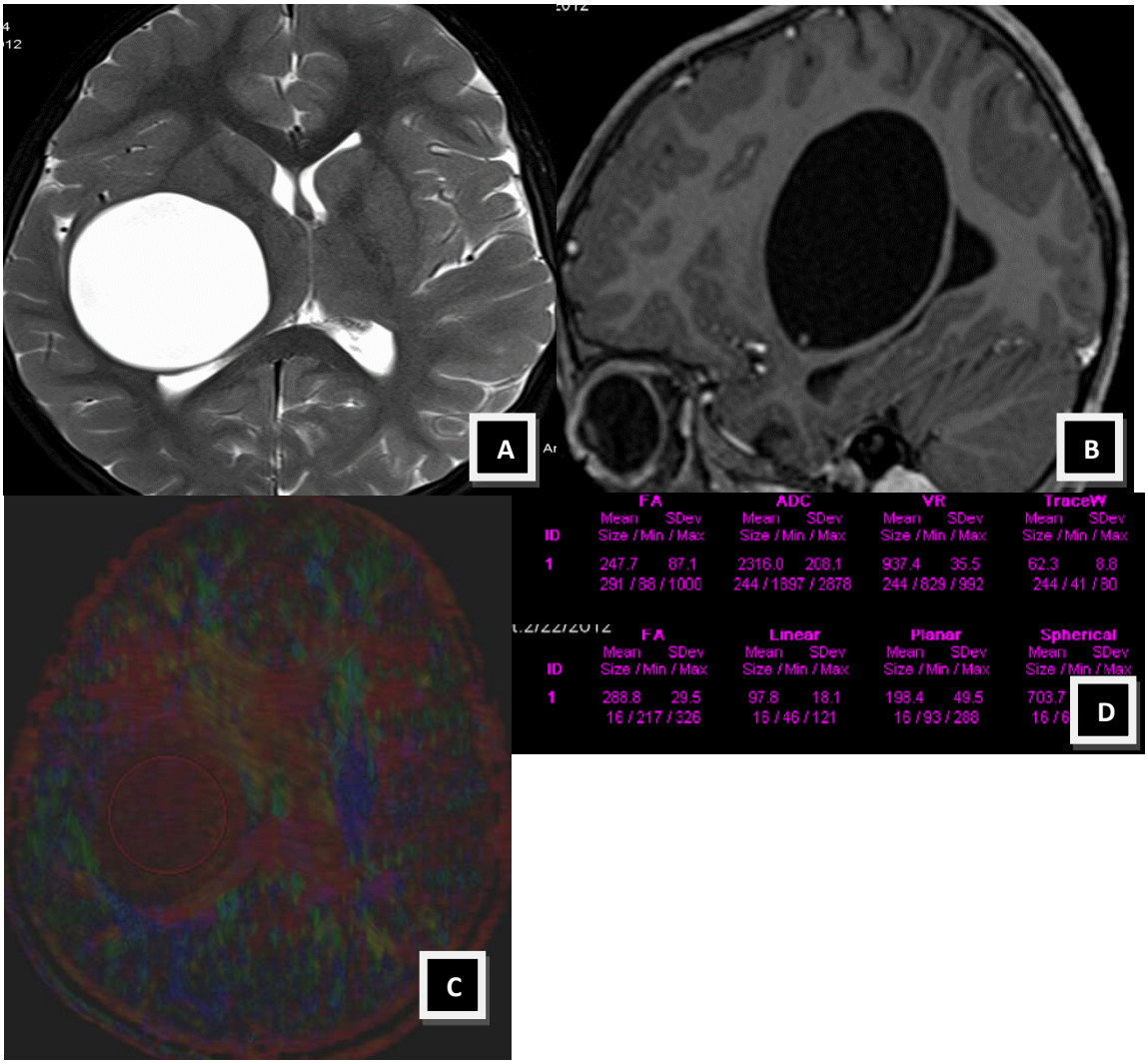



**Fig. 5: Case of Neurocysticercosis**

**A,** T2 weighted image shows a well-defined hyperintense lesion in right parietal lobe

**B**, T1 contrast shows enhancement of the eccentric scolex

**C,** FA map with ROI placement.

**D**, Derivation of metrics

## CASE 6

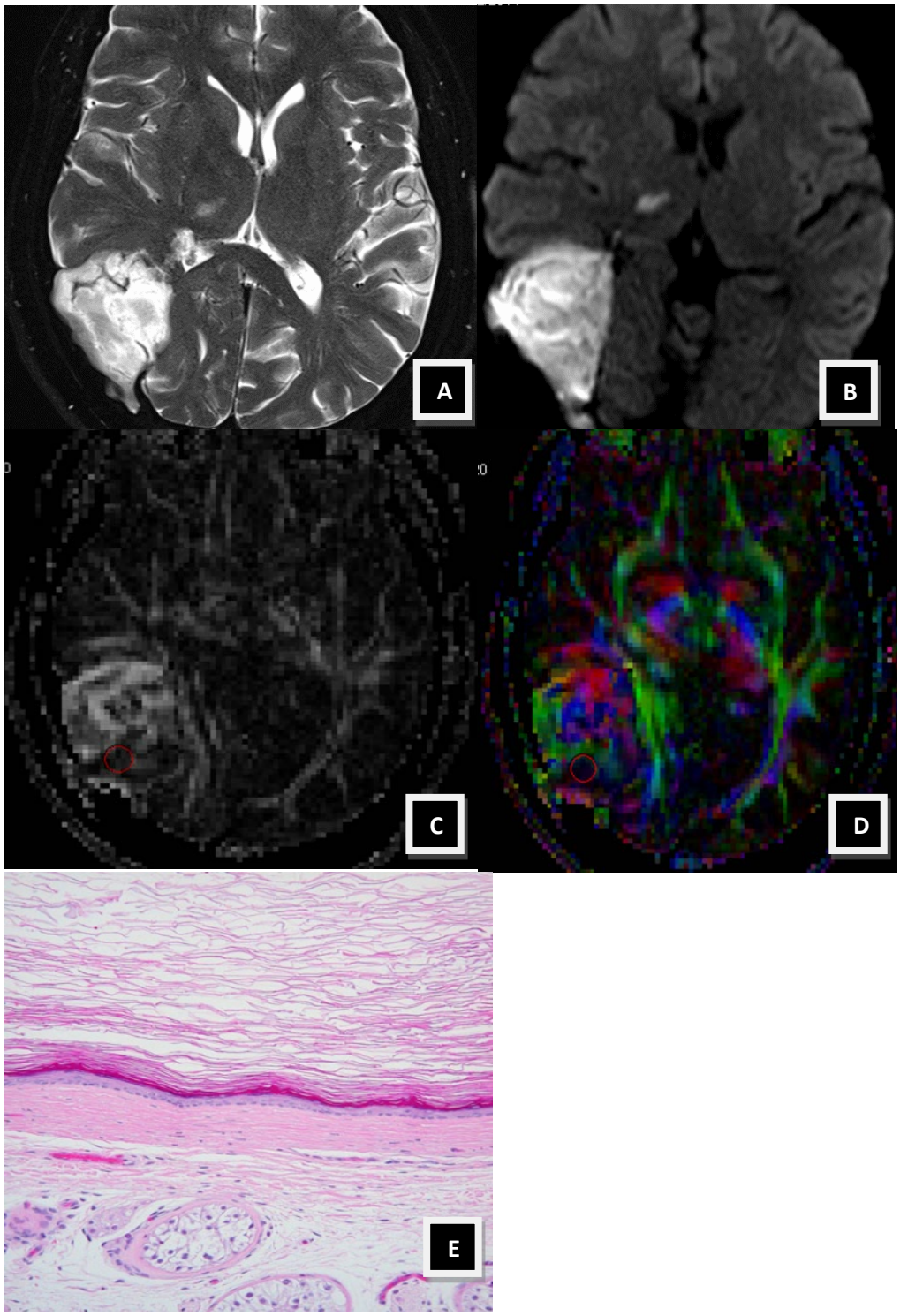



**Fig. 6: Case of Epidermoid**
**A,** T2 weighted image shows a well-defined hyperintense lesion in right parietal lobe
**B**, Diffusion shows restricted diffusion
**C, D** FA map with ROI placement.
**E**, Histopathology showing the tissue microstructure of epidermoid

## CASE 7

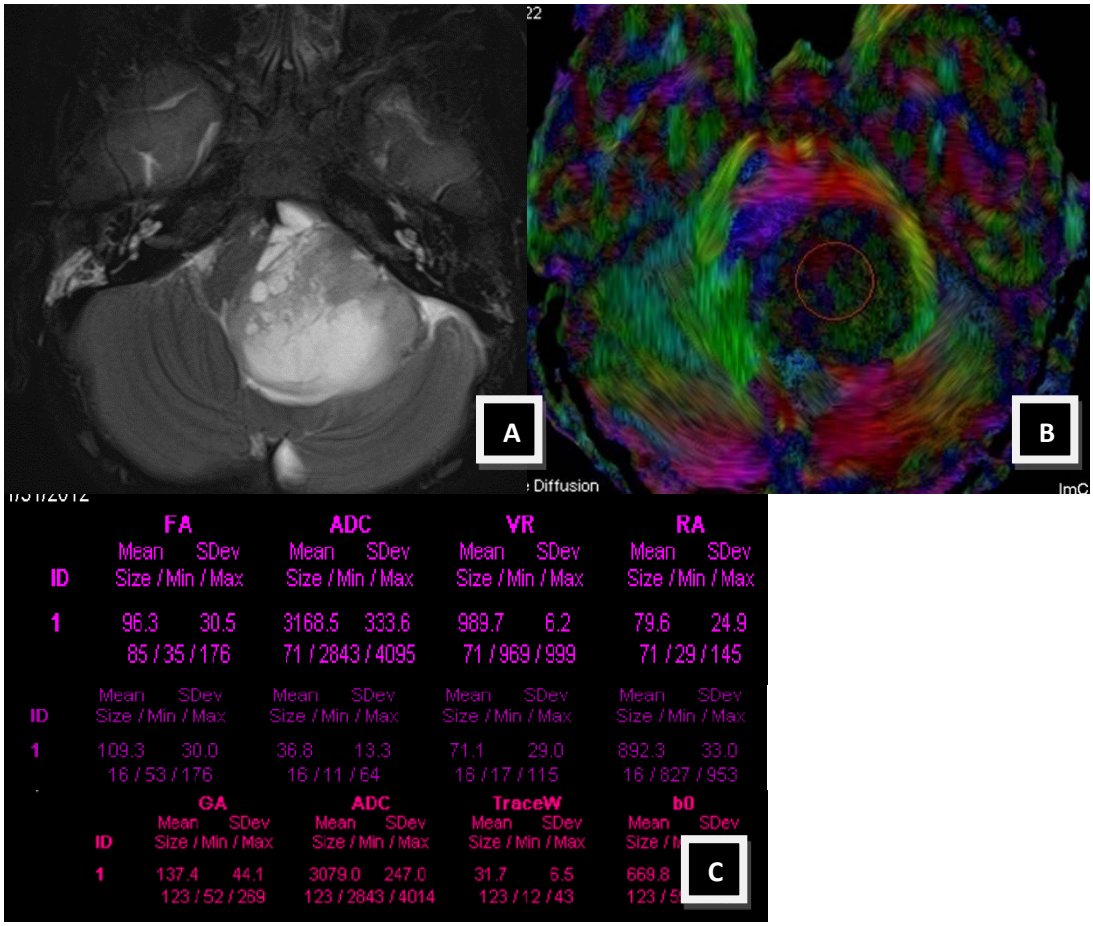



**Fig. 7: Case of Pilocytic Astrocytoma**

**A,** T2 weighted image shows a hyperintense lesion with solid areas in left cerebellar hemisphere

**B**, FA map

**C**, Derivation of metrics

## CASE 8

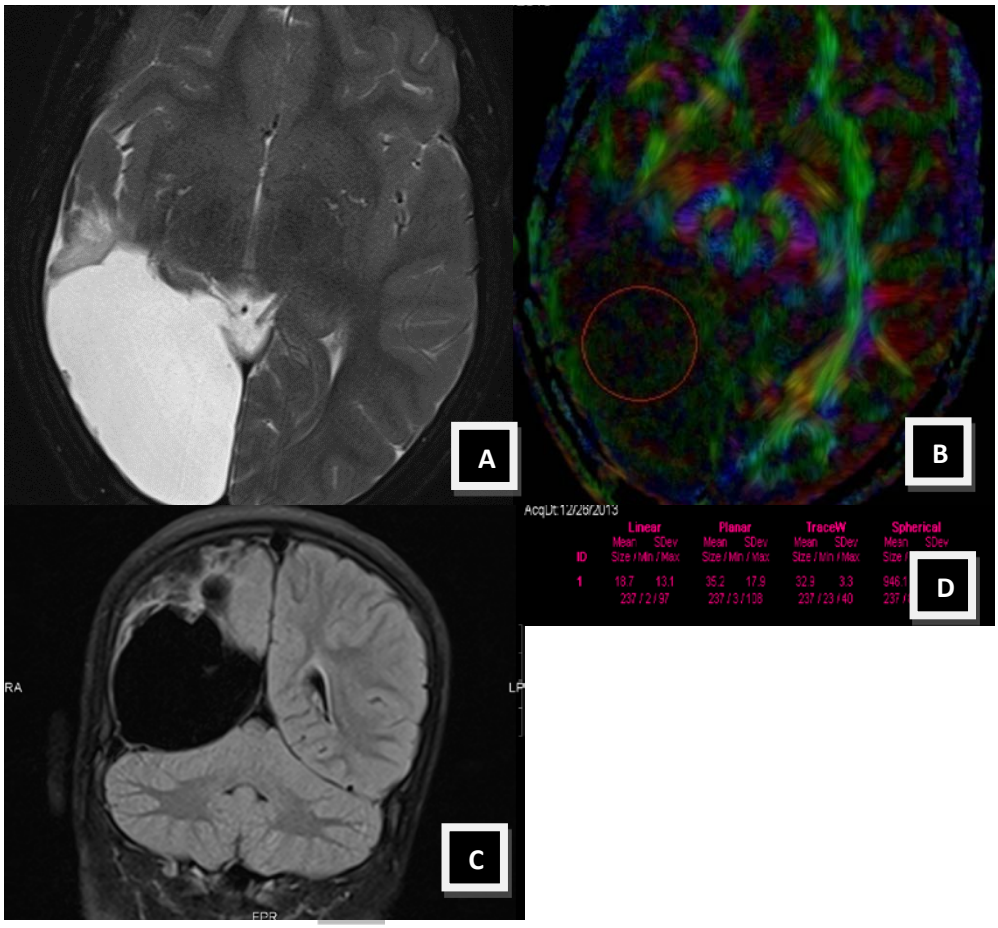



**Fig. 8: Case of Porencephalic Cyst**

**A,** T2 weighted image shows a large hyperintense cystic lesion in right parietooccipital lobe.

**B**, FA map with placement of ROI

**C**, MRS shows elevated inverted lactate peak.

## CASE 9

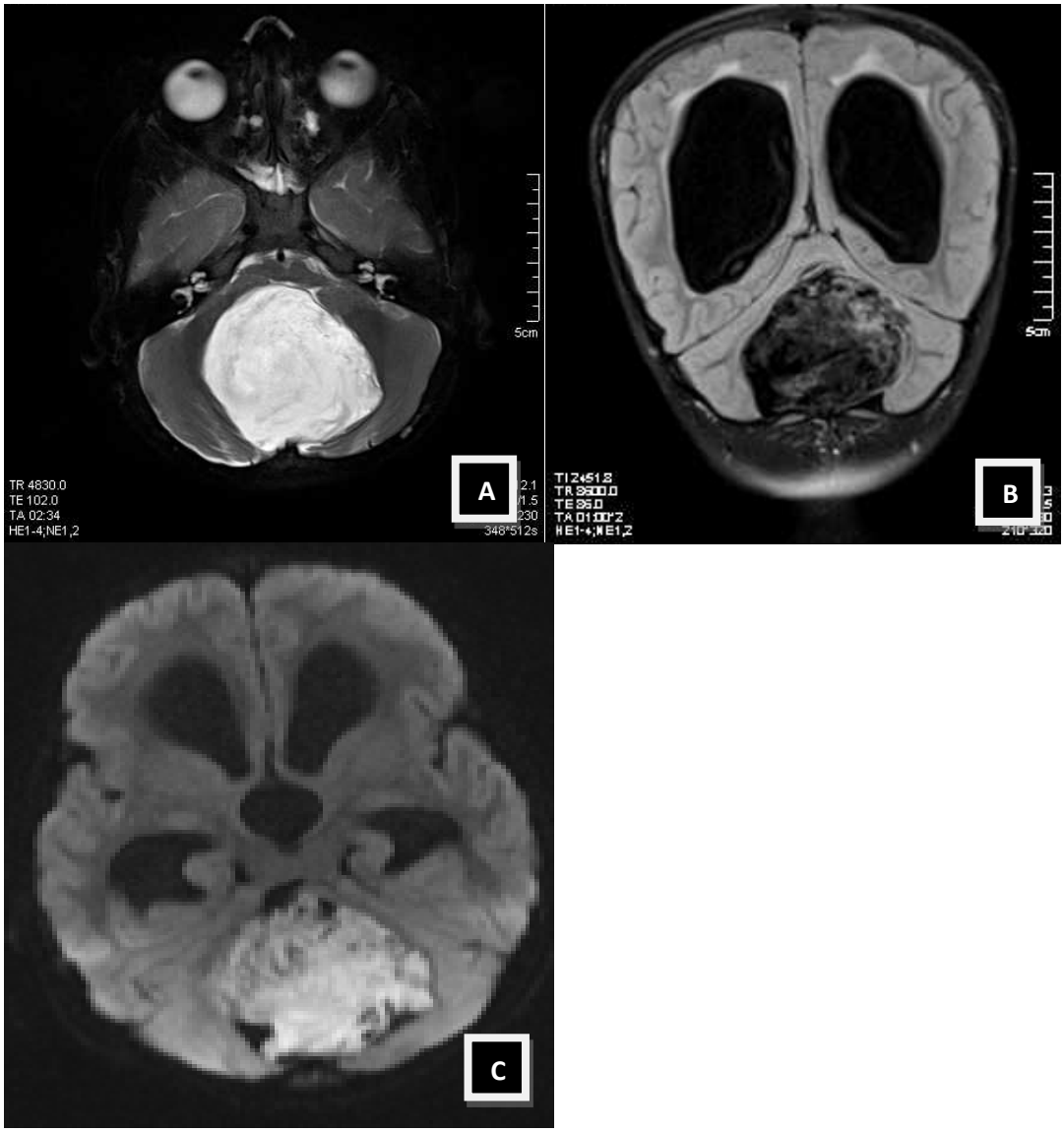



**Fig. 9:** Epidermoid cyst.

**A**, Axial T2,

**B**, T2flair Coronal images

**C,** Diffusion images

## CASE 10

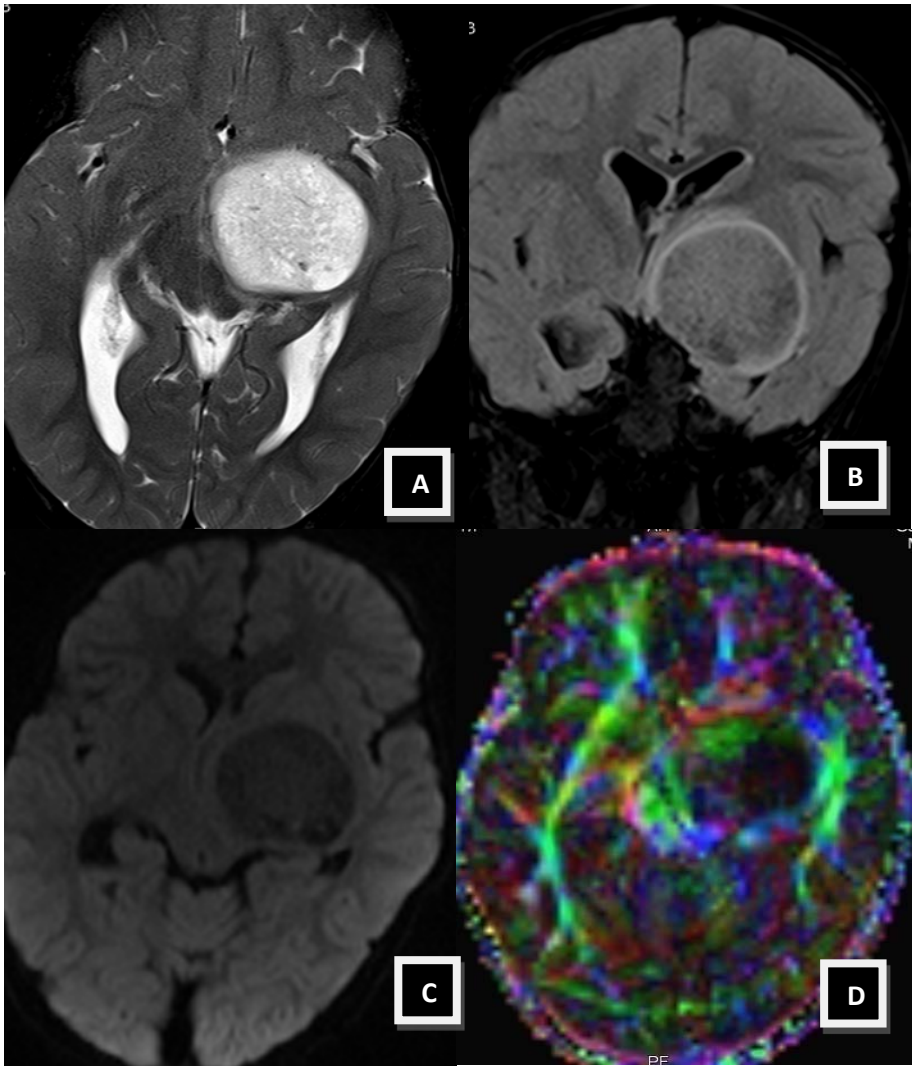



**Fig. 10:** Ganglioglioma

**A**, Axial T2,

**B**, T2flair Coronal images

**C,** Sagittal T1, diffusion images

D, FA maps

## CASE 11

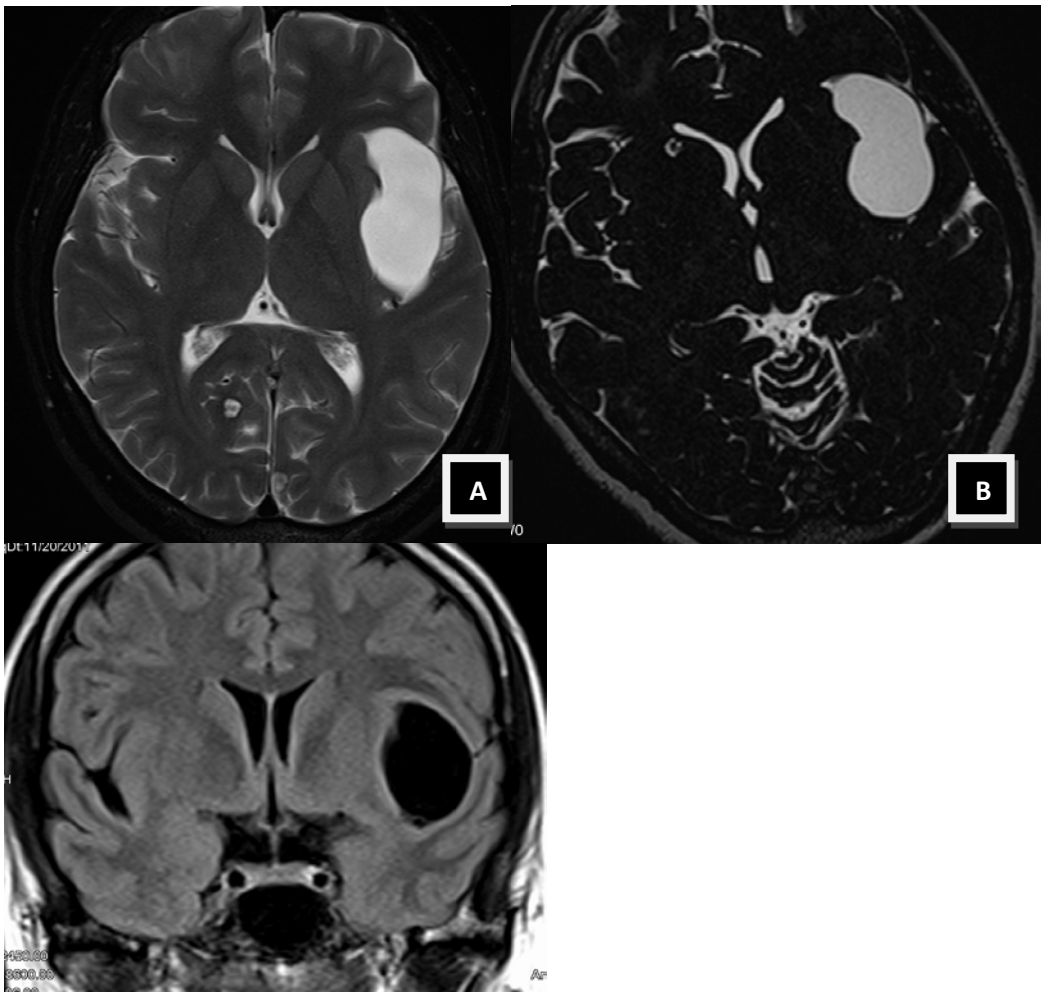



**Fig.11:** Neuro Cysticercosis.

**A**, Axial T2,

**B**, Space images

**C,** T2 flair Coronal

## CASE 12

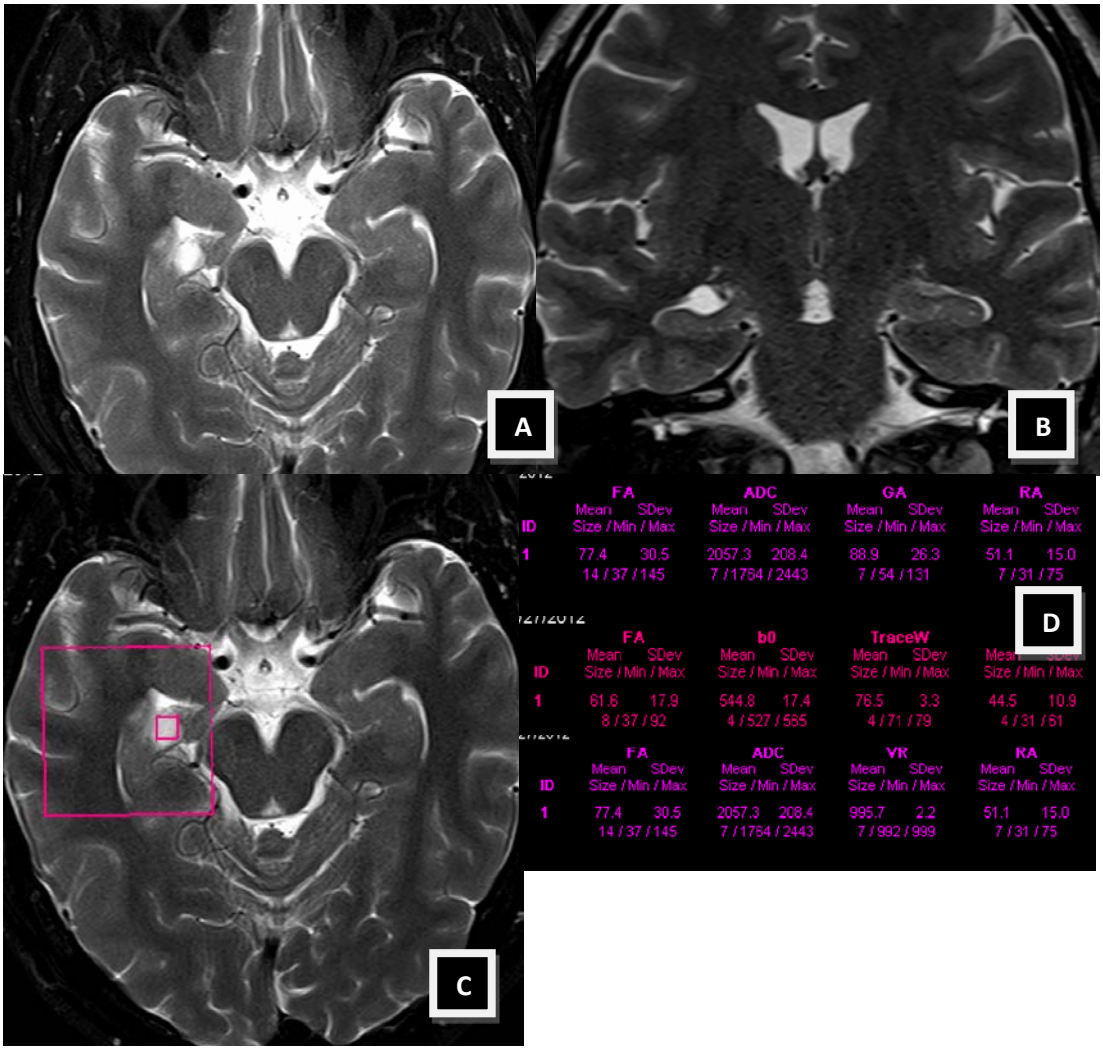



**Fig. 12:** Choroidal Fissure Cyst.

**A,** Axial T2,

**B**, coronal T2 images

**C**, ROI placement,

**D**, DTI metrics

## CASE 13

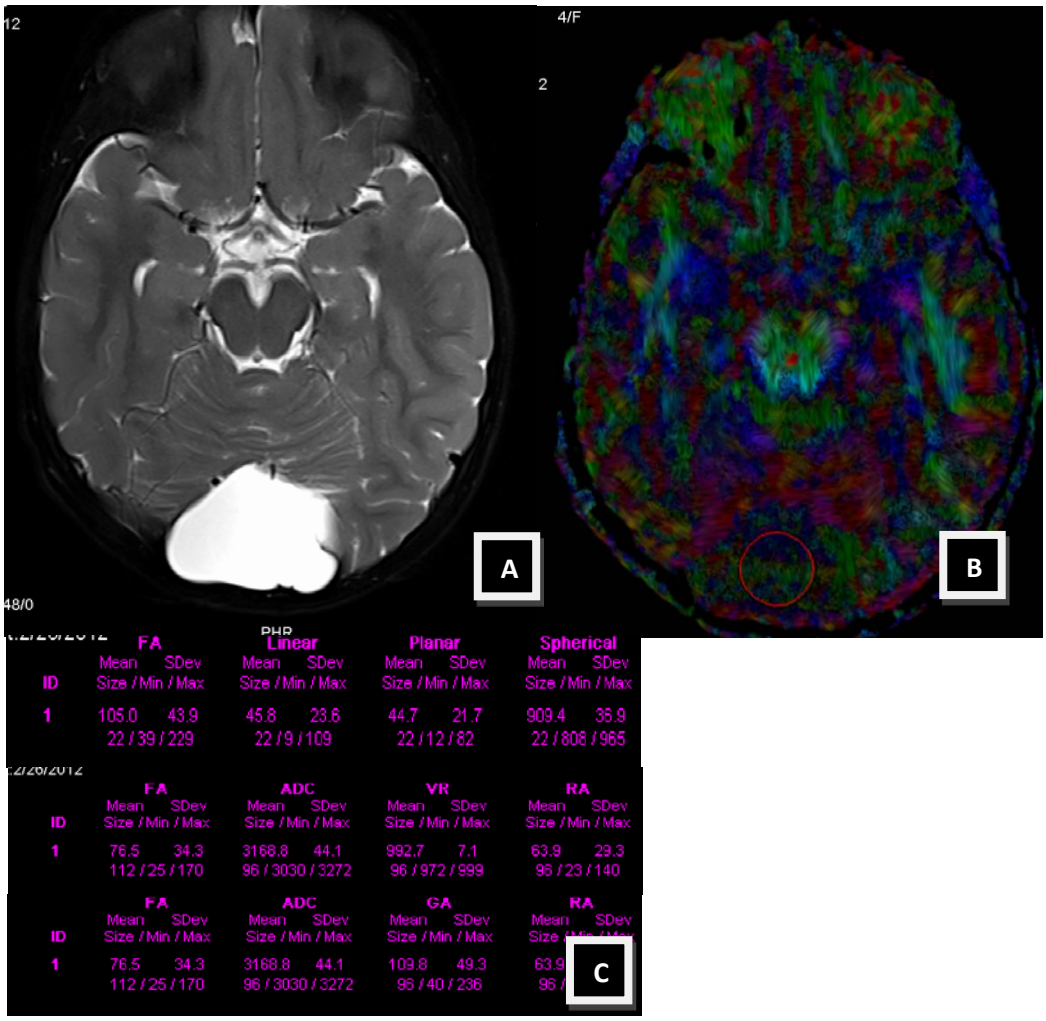



**Fig.13: Giant cistern magna**.

**A**, Axial T2

**B**, FA maps

**C**, DTI metrics images

## CASE 14

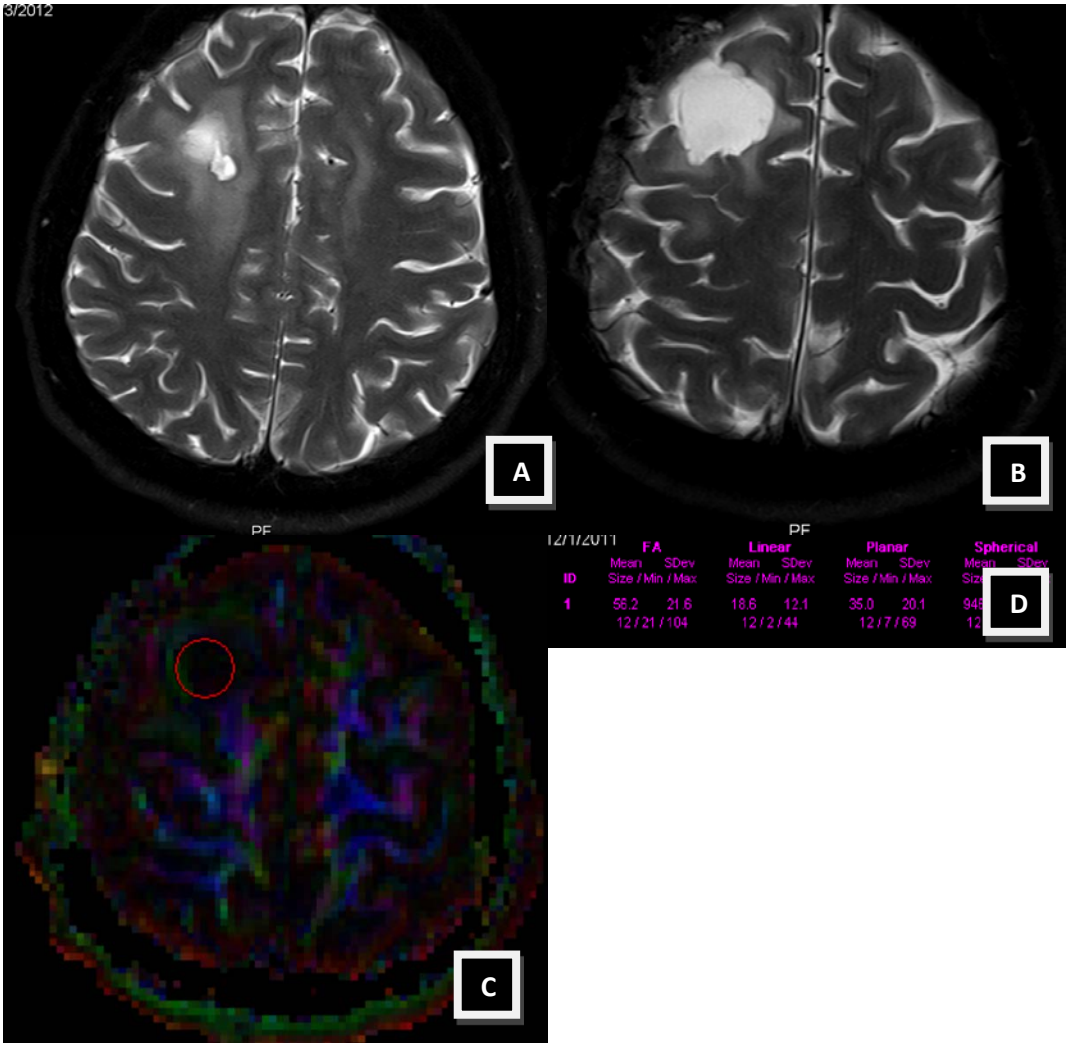



**Fig. 14 :** Glioma with Necrosis.

**A, B**, Axial T2

**C,** FA maps,

**D**, DTI metrics images

## CASE 15

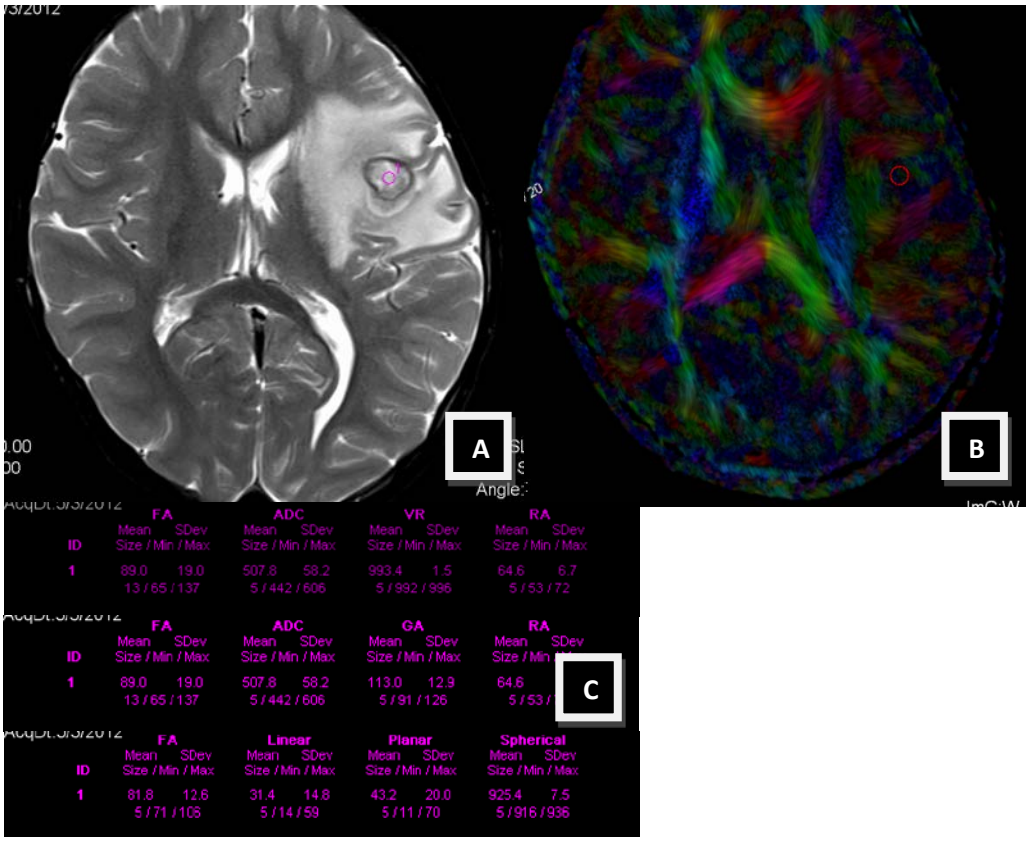



**Fig. 15:** 3 year old male with Cerebral Abscess.

**A**, Axial T2

**B**, FA maps

**C**, DTI metrics

## CASE 16

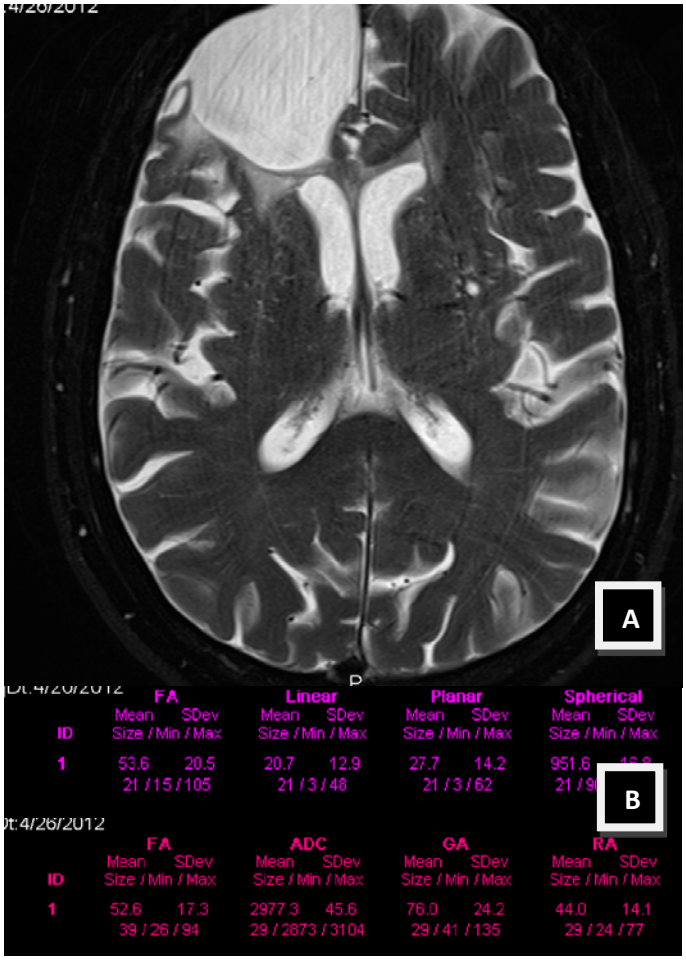



**Fig. 16:** Postoperative Cystic Encephalomalacia.

**A**, Axial T2, spectroscopy

**B,** DTI metrics

## CASE 17

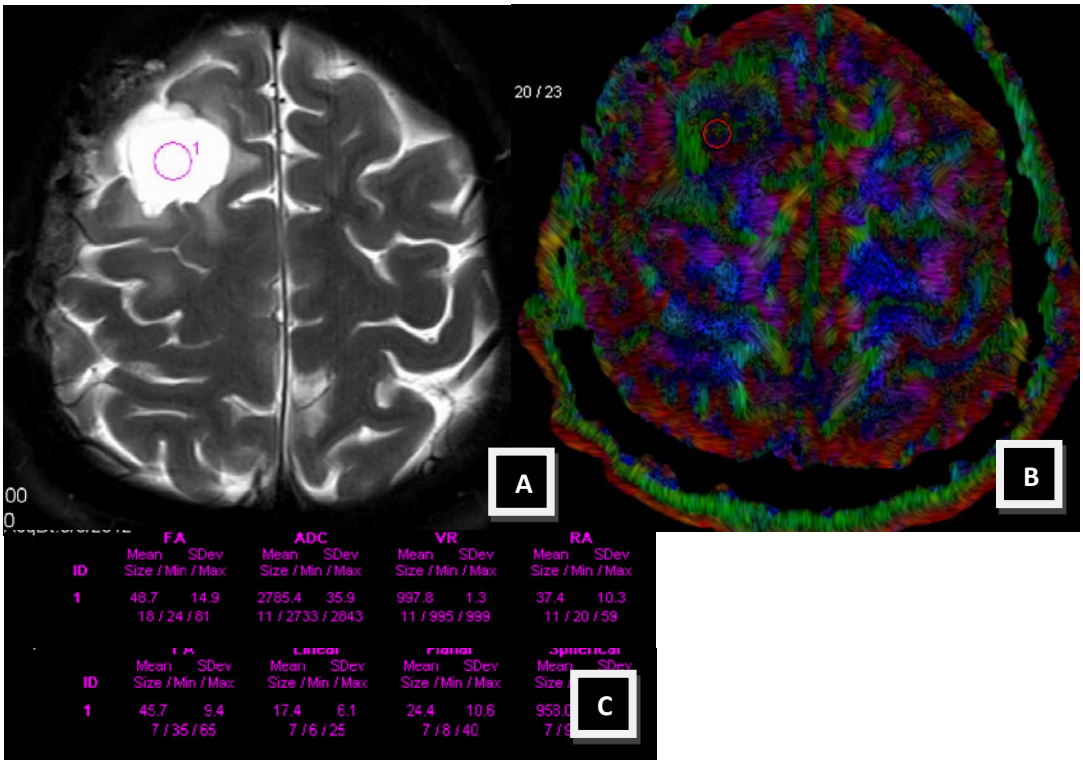



**Fig. 17: P**ost Treatment Cyst

**A**, T2 Axial

**B**, FA map

**C**, DTI metrics

## CASE 18

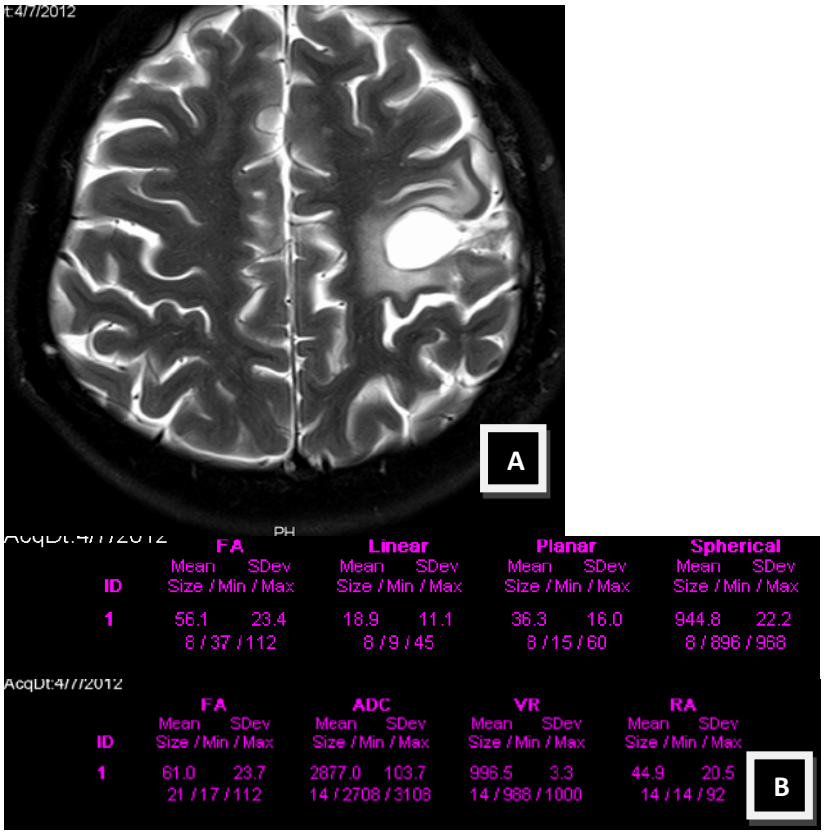



**Fig. 18:** Post Treatment Cyst

**A,** Axial T2

**B,** DTI metrics

# DISCUSSION

DTI is a non invasive imaging tool that provides information regarding the microstructural organization of our living human brain. FA represents tissue anisotropy and is the measure of the portion of the magnitude of the diffusion tensor due to anisotropy. FA of more than 0.4 generally suggests omnidirectional structural organization and a very high directional diffusivity. Geometric tensors consists,[13] of the linear anisotrophy, planar anisotrophy and the spherical anisotrophy. In Linear anisotrophy, CL the predominant direction of diffusion is along the direction of the largest eigenvalue (ƛ1 > ƛ2 and ƛ3). In planar anisotrophy, CP the diffusion is restricted to a plane spanned by the two largest eigenvalues (ƛ 1, ƛ 2 > ƛ 3). These three coordinates of tensor basics are then normalized to obtain the shape of the tensor, which gives useful information as to the linearity and anisotropy of the concerned structure.

Developmental cyst (n = 25) such as arachanoid cyst(Fig.1) showed highest mean diffusivity MD of 2.838 ± 0.430 x 10(-3) mm(2)/s & lowest TRACE W = 35 ± 20. The parameter TRACE W has the highest diagnostic accuracy showing Area Under the Curve, AUC = 0.8, with a sensitivity of 92% & specificity of 81%. These are mostly composed of just CSF, not much cellular materials, to cause hindrance in the movement of water molecules which is reflected by the findings in our study with the highest mean diffusivity , and very low fractional anisotrophy compared to all other cysts.

Acquired porencephalic cyst (n = 5) (Fig.2) showed lowest fractional anisotrophy FA = 0.056 ± 0.009.Also in acquired cysts the parameter relative anisometry RA has the highest diagnostic accuracy showing Area under the Curve, AUC = 0.9, with a sensitivity of 100% & specificity of 88%. These cysts are similar to developmental cysts showing lowest fractional anisotrophy compared to other cysts.

Neurocysticercosis (n=7) (Fig.4) showed higher mean fractional anisotrophy, FA = 0.0915 ± 0.192 next to epidermoid. In Neurocysticercosis the parameter FA has the highest diagnostic accuracy showing Area Under the Curve, AUC = 0.86, with a sensitivity of 85.7% & specificity of 81.8%. The FA values of these cysts showed wide variation since these lesions could be in varying stages of evolution. Two of the larger lesions show significantly higher FA values, while the smaller cysts which measured 5-10mm shows lower FA values. Hence how far it could be generalised for the diagnosis of neurocysticercosis is beyond the limits of our study.

Low grade tumoral cysts(n=10)(Fig.4) showed lower mean fractional anisotrophy, FA = 0.084 ± 0.013, MD = 2.69 x 10(-3) mm(2)/s. In a similar way did high grade tumoral cysts (n=5) (Fig.5) showed lower mean fractional anisotrophy, FA = 0.06 ± 0.007, MD = 2.49 x 10(-3) mm(2)/s. Our study did not show much factors to differentiate high from low grade tumoral cysts. But the cut off values to differentiate low grade from high grade tumours will require further more studies with a large sample volume.

Abscess (n = 5) (Fig. 6) shows lower mean fractional anisotrophy,[14-19], FA = 0.078 ± 0.018, with lowest mean diffusivity, MD = 0.777 ± 0.55 x 10(-3) mm(2)/s and lowest Geodesic anisometry, GA, = 78.760 ± 19.12. Also in abcesses the parameter mean diffusivity, MD has the highest diagnostic accuracy showing Area Under the Curve, AUC = 0.9, with a sensitivity of 100% & specificity of 84.2%. The study done by Rakesh K. Gupta, Khader M. Hasan, Asht M. Mishra demonstrates that brain abscess cavity shows regions of increased fractional anisotrophy, FA values with restricted mean diffusivity compared with other cystic intracranial lesions. This statement is very much contradictory to the results obtained in our study in that the FA values were very much less when compared to Epidermoid as well as Neurocysticercosis. This could be explained by the fact that Epidermid cysts were not included in their study which we have included it in our study. One another possibility is that the abscesses could be in varying stages of evolution, in a similar way does Neurocysticercosis. The purulent material obtained from the abscess cavity at the time of surgery showed inflammatory cells, necrotic cellular debris, proteins, and amino acids as well as low molecular weight metabolites. This explains for the lowest Mean diffusivity (MD) obtained in abscess cavity compared to all their cysts. One possibility could be that these cells are tightly packed, thus reducing the extracellular space and therefore are responsible for a large anisotropy in the abscess cavity. In abscesses the microorganisms cause aggregation of leukocytes and release of large amounts of chemo tactic peptides and an up-regulation of intracellular adhesion molecules (ICAM-1) that are recruited to the cell surface

to mediate their aggregation via lymphocyte function associated molecule 1. DWI can be used to differentiate pyogenic abscess from other ring-enhancing mass lesions.

In our study Epidermoid cyst (n=5) (Fig. 7)showed highest mean fractional anisotrophy, FA = 0.509 ± 0.077, lower mean diffusivity, MD = 0.866 ± 0.140 x 10(-3) mm(2)/s, highest relative anisotrophy, RA = 477.200 ± 27.381,lowest volumetric ratio, VR = 686.200 ± 46.397, highest Geodesic anisometry, GA = 920 ± 42.60, grossly different linear component,[13], CL = 218.5, planar component CP =332.920, spherical component, CS = 448.62, highest B0 =859.34 & highest TRACE W = 413.6 ± 27.745 compared to all other cysts. Also in Epidermoid cysts all the parameters showed a very good diagnostic accuracy showing Area Under Curve(AUC)=1, with a sensitivity of 100% & specificity of 100%. With regards to epidermoid cysts, in the study done by Santhosh K, Bejoy thomas observed a high fractional anisotropy (FA) & planar anisometry (Cp) indicating a highly structured orientation of the tissue, fibers, or white matter tracts & this is illustrated in Fig 8 which explains the shape of the tensor model. Similar results were obtained in our study. Hence in our study epidermoid cysts revealed an entirely different value for all the parameters with a P value < 0.05. Another difference comparing the study done by Santhosh K, Bejoy Thomas is that they have observed higher Cp and lower Cl in epidermoid because they had compared to white matter tracts. In our study since we have compared to other cysts it revealed a higher CP and CL also. Epidermoid cysts are derived from inclusions of surface ectoderm into the

developing brain and have concentric lamellated internal architecture due to continuous accumulation of keratin debris produced by the surface epithelium. The keratin content of epidermoid cysts were visualised as free water-like in a few number of cases regardless of the sequence used, even though non- CSF material is present within these lesions. The MR behaviour of the content of these cysts depends on the amount of lipids present, which however can be differentiated by DTI, which also gives clues to the internal characteristics of these cysts.

**Limitation of the study:**

Factors such as cellularity, viscosity, permeability, and histology can affect the diffusivity of water. The values of parameters measured with DTI are the summation effect of all these micro structural barriers. Because in vivo quantification of the individual effect of each factor is currently impossible, we could not definitely state that the changes of tensor metrics were directly related to the differences in histological features alone thus explaining the limitation of the study. The cysts were grossly grouped into 7 groups for the purpose of statistical comparison. So the differentiations of individual cysts within the group were not done. In some of the groups the sample size was less. So the significance of each of the parameter could not be generalised. Few other important pathological cysts such as hydatid cyst were not included in our study. All the cysts were not confirmed by the gold standard histological diagnosis.

# CONCLUSION

Considering the clinical importance of distinguishing cystic intracranial lesions that require further therapy from those that need only follow-up DTI with calculated FA,MD values add more information to MRI in the differentiation of intracranial cystic mass lesions. The quantitative nature of DTI will play a role in assessing the outcome of clinical trials, as an additional surrogate marker in monitoring the therapeutic response. Careful studies to validate DTI and its metrics will allow it to become more applicable clinically and can affect therapeutic decision-making and eventually patient outcome. This will ensure future acceptance of the implementation of tools such as DTI for use in determining the safety and efficacy of novel therapies.

# IMPACT OF STUDY & RECOMMENDATIONS

This study implicates the need for inclusion of DTI in the routine protocol of imaging cystic intracranial mass lesions with higher magnetic strength, instead of visual inspection, advanced post processing techniques can help to analyse the lesions voxel by voxel, evaluation individual group of pathologies with large sample size, familiarity of normal DTI images and appearances of various pathologies, and knowledge about artefacts in DTI images are required.

Hence Diffusion tensor imaging proves as a powerful tool for investigating the tissue microstructure and finding new clinical applications for DTI is a hot topic in the MR research community.

# ANNEXURES

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# ABBREVIATIONS

| | | |
|---|---|---|
| DTI | : | Diffusion tensor imaging |
| FA | : | Fractional anisotrophy |
| MD | : | Mean diffusivity |
| RA | : | Relative anisotrophy |
| GA | : | Geodesic anisometry |
| CL | : | linear tensor |
| CP | : | planar tensor |
| CS | : | spherical tensor. |
| VR | | Volume ratio |
| TRACE w | | TRACE weighted VALUE |

# PROFORMA
# DEPARTMENT OF RADIOLOGY

**STANLEY MEDICAL COLLEGE.**
**CHENNAI-1, TAMILNADU**

## TITLE:"ROLE OF DTI METRICS IN DIFFERENTIATION OF CYSTIC

## INTRACRANIAL MASS LESIONS"

**WEIGHTED MR IN INTRACRANIAL CYSTIC LESIONS"**

NAME: AGE/ SEX :
STUDY NO:
CLINICAL HISTORY:
RISK FACTORS:

| **TECHNIQUE** | | OBSERVATION |
|---|---|---|
| **Conventional MRI** | **Size, location** | |
| | **T1** | |
| | **T2** | |
| | **flair** | |
| | **GRADIENT** | |
| | **space** | |
| | **Contrast enhancement** | |
| **DTI** | **FA** | |
| | **MD** | |
| | RA | |
| | **GA** | |
| | **VR** | |
| | **CL** | |
| | **CP** | |
| | **CS** | |
| | **TRACE W** | |
| | **B0** | |
| **DIAGNOSIS** | | |
| **BIOPSY** | | |
| **FOLLOWUP** | | |

# KEY TO MASTER CHART

1)-Column 1- S No – Serial number

2)-Column 5 – FA – Fractional Aniostrophy (0 TO 1)

3)-Column 6 – MD: Mean diffusivity UNIT -$10^{-3}$ $mm^2$/sec

4)-Column 7 -RA: Relative anisotrophy

5)-Column 8 –VR:Volume ratio

6)-Column 9 -GA: Geodesic anisometry

7)-Column 10 -CL: linear tensor

8) Column 11-CP: planar tensor

9)-Column 12-CS : spherical tensor.

10)-Column 13-B0

11)-Column 14-TRACE w- TRACE weighted VALUE

# CONSENT FORM

**GOVT. STANLEY MEDICAL COLLEGE, CHENNAI – 600001**

## INFORMED CONSENT

**Study title:- "ROLE OF DTI METRICS IN DIFFERENTIATION OF CYSTIC INTRACRANIAL MASS LESIONS"**

Patient's Identification No : _____ Patient's Name: _____
Patient's Date of Birth : ___/ ___/ _____

I confirm that I have read and understood the Information sheet for the above study. I have had the opportunity to ask the questions and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that i am free to withdraw at any time , without giving any reason without my legal rights being affected.

I understand that clinical study personnel, the Ethics Committee and the regulatory Authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even it i withdraw from the study. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not restrict the use of any data or results that arise from this study. I agree not to withhold any information about my health from the investigator and will convey the same truthfully.

I agree to take part in the above study and to comply with the instructions given during the study and to faithfully co-operate with the study team , and to immediately inform the study staff, if I suffer from any deterioration in my health or well- being or any unexpected or unusual symptoms.

I hereby consent to participate in this study. I consent to give my medical history, undergo complete physical examination and diagnostic tests including haematological , biochemical and urine examination etc.

Signature/ Thumb Impression of the Patient : _____ Place _____ Date:_____

Patient's Name & Address :

_____

_____

Signature of the Investigator: _____ Place: _____ Date: _____

Study Investigator's Name : _____ Institution: _____

*Signature of the witness _____Place _____Date:_____

*Name and Address ot the Witness :

_____

**** Mandatory for uneducated patients ( where thumb impression has been provided above )***

**GOVT. STANLEY MEDICAL COLLEGE, CHENNAI – 600001**

## சுய ஒப்புதல் படிவம்

ஆய்வு செய்யப்படும் தலைப்பு :

**D.T.I** மூலம் மூளையில் ஏற்படும் வலிப்பு நோயை ஆய்வு செய்தல்

ஆராய்ச்சி நிலையம்:கதிர் வீச்சு இயல்துறை,

தமிழ்நாடு அரசு ஸ்டான்லி மருத்துவக்கல்லூரி & மருத்துவமனை,

சென்னை - 600 001.

பங்கு பெறுபவரின் பெயர் :

பங்குபெறுபவரின் எண் :

பங்கு பெறுவர் இதனை (√) குறிக்கவும்.

மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டது.

நான் இவ்வாய்வில் தன்னிச்சையாகதான் பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த கட்டத்திலும் எந்த சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்து கொண்டேன்.

இந்த ஆய்வு சம்மந்தகமாகவோ, இதை சார்ந்த மேலும் ஆய்வு மேற்கொள்ளும் போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். நான் ஆய்வில் இருந்து விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன்.

இந்த ஆய்வின் மூலம் கிடைக்கும் தகவல்களையும், பரிசோதனை முடிவுகளையும் மற்றும் சிகிச்சை தொடர்பான தகவல்களையும் மருத்துவர்

மேற்கொள்ளும் ஆய்வில் பயன்படுத்திக்கொள்ளவும் அதை பிரசுரிக்கவும் என் முழு மனதுடன் சம்மதிக்கிறேன்.

இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக்கொள்கிறேன். எனக்கு கொடுக்கப்பட்ட அறிவுரைகளின்படி நடந்து கொள்வதுடன் இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதியளிக்கிறேன். என் உடல் நலம் பாதிக்கப்பட்டாலோ அல்லது எதிர்பாராத வழக்கத்திற்கு மாறான நோய்க்குறி தென்பட்டாலோ உடனே அதை மருத்துவ அணியிடம் தெரிவிப்பேன் என உறுதி அளிக்கிறேன்.

பங்கேற்பவரின் கையொப்பம் ..... இடம் ..... தேதி

கட்டைவிரல் ரேகை

பங்கேற்பவரின் பெயர் மற்றும் விலாசம் .....

ஆய்வாளரின் கையொப்பம் ..... இடம் ..... தேதி

ஆய்வாளரின் பெயர் .....

# ETHICAL COMMITTEE APPROVAL LETTER

INSTITUTIONAL ETHICAL COMMITTEE,
STANLEY MEDICAL COLLEGE, CHENNAI-1

Title of the Work : Role of DTI metrics in differentiation of Cystic intracranial mass lessions.

Principal Investigator : Dr. M Priya

Designation : PG in MD (Radio Diagnosis)

Department : Department of Radio Diagnosis
Government Stanley Medical College,
Chennai-01

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 02.07.2014 at the Council Hall, Stanley Medical College, Chennai-1 at 2PM

The members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The Principal investigator and their team are directed to adhere to the guidelines given below:

1. You should inform the IEC in case of changes in study procedure, site investigator investigation or guide or any other changes.
2. You should not deviate from the area of the work for which you applied for ethical clearance.
3. You should inform the IEC immediately, in case of any adverse events or serious adverse reaction.
4. You should abide to the rules and regulation of the institution(s).
5. You should complete the work within the specified period and if any extension of time is required, you should apply for permission again and do the work.
6. You should submit the summary of the work to the ethical committee on completion of the work.

MEMBER SECRETARY,
IEC, SMC, CHENNAI

MEMBER SECRETARY
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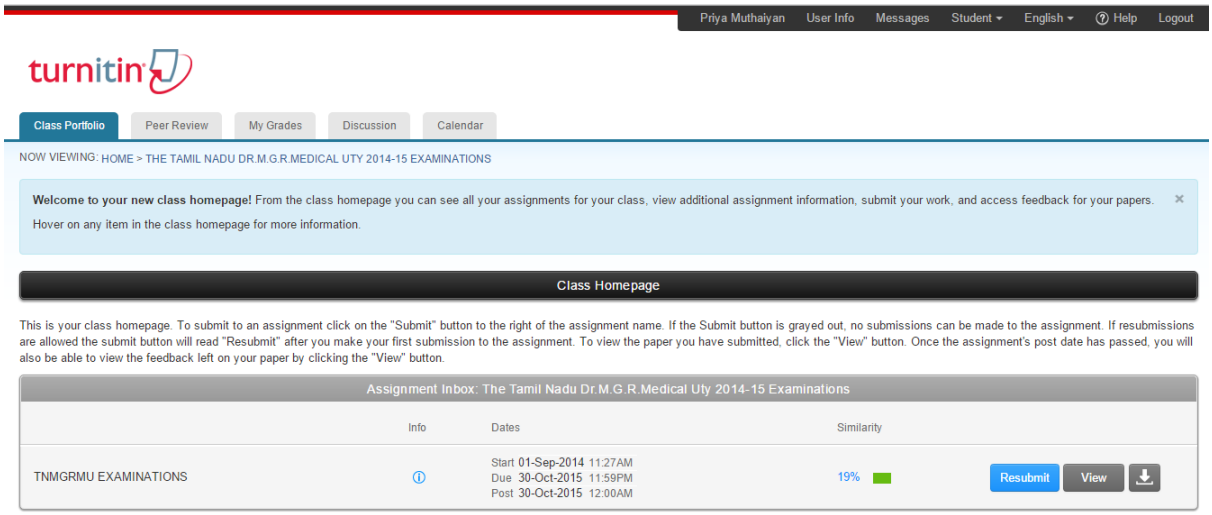
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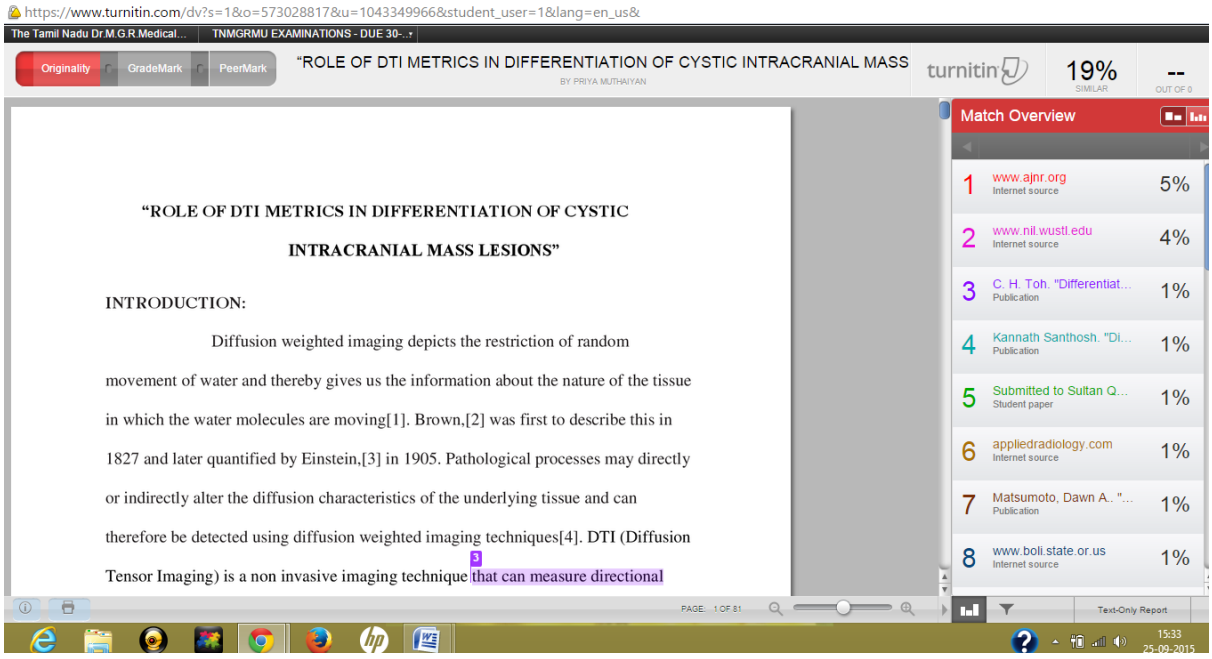
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"ROLE OF DTI METRICS IN DIFFERENTIATION OF CYSTIC
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INTRODUCTION:
Diffusion weighted imaging depicts the restriction of random movement of water and thereby gives us the information about the nature of the tissue in which the water molecules are moving[1]. Brown,[2] was first to describe this in 1827 and later quantified by Einstein,[3] in 1905. Pathological processes may directly or indirectly alter the diffusion characteristics of the underlying tissue and can therefore be detected using diffusion weighted imaging techniques[4]. DTI (Diffusion Tensor Imaging) is a non invasive imaging technique that can measure directional
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**MASTER CHART**

| s.no | NAME | | age /sex | AGE | SEX | diagnosis | GROUP | FA | MD | RA | VR | GA | CL | CP | CS | B0 | TRACE W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BHARATH | | 14/M | 14 | 1 | DNET | 4 | 0.0534 | 2.246 | 43.6 | 996.9 | 75.2 | 20.7 | 27.9 | 951.4 | 714.4 | 75.5 |
| 2 | PRAVEEN SONITHA | | 13/F | 13 | 2 | DNET | 4 | 0.103 | 2.468 | 86.8 | 986.3 | 147.5 | 47.2 | 41.3 | 912.5 | 656.3 | 57.7 |
| 3 | SURABHI | | 10/F | 10 | 2 | DNET | 4 | 0.082 | 2.943 | 53.6 | 987.6 | 140.2 | 21.7 | 28.9 | 949.4 | 702.6 | 62.4 |
| 4 | BHUVANESH | | 10/M | 10 | 1 | ARACHNOID CYST | 1 | 0.051 | 2.982 | 44.2 | 999.1 | 140 | 18.6 | 26.7 | 955 | 604.4 | 29.6 |
| 5 | G0PADAS | | 25/F | 25 | 2 | ARACHNOID CYST | 1 | 0.056 | 2.225 | 43.5 | 992.7 | 143.6 | 16.6 | 26.7 | 957 | 603.5 | 27.4 |
| 6 | AMUDHA | | 40/F | 40 | 2 | ARACHNOID CYST | 1 | 0.091 | 3.06 | 82.2 | 990.7 | 141.4 | 40.6 | 54.3 | 905 | 605.8 | 28.4 |
| 7 | SURULINARAYANAN | | 28/M | 28 | 1 | ARACHNOID CYST | 1 | 0.052 | 2.935 | 42.8 | 996.9 | 78.1 | 17.7 | 30.5 | 952 | 646.3 | 33.8 |
| 8 | RAMASUBRAMANIYAM | | 66/M | 66 | 1 | ARACHNOID CYST | 1 | 0.074 | 2.885 | 41.2 | 997 | 104.1 | 17.6 | 27.7 | 955 | 766.8 | 40.6 |
| 9 | FAREEZ | | 4/M | 4 | 1 | ARACHNOID CYST | 1 | 0.07 | 3 | 55.4 | 994 | 96 | 22.9 | 42.4 | 934.7 | 645.9 | 32 |
| 10 | ANITHA | | 4/F | 4 | 2 | ARACHNOID CYST | 1 | 0.093 | 3.16 | 76.3 | 990 | 131.8 | 33.5 | 54.2 | 912.2 | 558 | 23.8 |
| 11 | NETHAJI | | 28/M | 28 | 1 | ARACHNOID CYST | 1 | 0.111 | 3.12 | 91.4 | 985.6 | 159.2 | 36.9 | 71.3 | 891.8 | 452.5 | 20.3 |
| 12 | HARIKRISHNAN | | 2/M | 2 | 1 | ARACHNOID CYST | 1 | 0.178 | 3.339 | 49.7 | 964.4 | 154.1 | 78.7 | 74.6 | 846.7 | 611.2 | 21.7 |
| 13 | VAIBAV | | 6m/M | 6months | 1 | ARACHNOID CYST | 1 | 0.102 | 3.22 | 54.4 | 987.9 | 162.2 | 30.5 | 53.2 | 916.2 | 602.4 | 28.3 |
| 14 | SASIKALA | | 40/F | 40 | 2 | NCC | 3 | 0.35 | 2.877 | 60.2 | 956 | 90.2 | 30.1 | 37.1 | 932.8 | 820.1 | 40.5 |
| 15 | VIJAY JOSWA | | 8/M | 8 | 1 | NCC | 3 | 0.247 | 2.316 | 55.8 | 937.7 | 91.4 | 97.8 | 198.4 | 703.8 | 831.6 | 43.2 |
| 16 | MURUGAN | | 32/M | 32 | 1 | NCC | 3 | 0.67 | 2.939 | 56.8 | 994 | 95.6 | 27.1 | 34.1 | 938 | 827.1 | 41.5 |
| 17 | POONUSWAMY | | 52/M | 52 | 1 | NCC | 3 | 0.091 | 1.729 | 59.4 | 994.1 | 102.9 | 24.7 | 45.1 | 930 | 526 | 94 |
| 18 | PRAVEEN RAJAN | | 20/M | 20 | 1 | NCC | 3 | 0.137 | 2.427 | 58.1 | 953.1 | 98.2 | 22.6 | 43.2 | 934.2 | 832 | 43.1 |
| 19 | LAVANYA | | 12/F | 12 | 2 | NCC | 3 | 0.213 | 2.31 | 57.1 | 956.1 | 99.2 | 26.1 | 47.2 | 926.7 | 830.2 | 41.2 |
| 20 | AHAMED ALI | | 48/M | 48 | 1 | NCC | 3 | 0.227 | 2.24 | 54.2 | 951.3 | 89.9 | 29.1 | 36.1 | 934.8 | 721.2 | 53.2 |
| 21 | SELVAM | | 25/M | 25 | 1 | EPIDERMOID | 7 | 0.525 | 0.782 | 479 | 661 | 946 | 217.3 | 334.6 | 448.2 | 883.1 | 404.2 |
| 22 | VARADHARAJAN | | 21/M | 21 | 1 | EPIDERMOID | 7 | 0.428 | 0.846 | 470 | 660 | 942 | 216.1 | 332.4 | 451.5 | 888 | 387.2 |
| 23 | MADHANAGOPAL | | 56/M | 56 | 1 | EPIDERMOID | 7 | 0.626 | 1.11 | 446 | 640 | 945 | 219.2 | 337.2 | 443.6 | 873.2 | 392.2 |
| 24 | PRADEEP | | 15/M | 15 | 1 | EPIDERMOID | 7 | 0.512 | 0.771 | 470 | 749 | 846 | 221.6 | 323.8 | 454.6 | 782.2 | 452.2 |
| 25 | SUNITHA | | 32/F | 32 | 2 | EPIDERMOID | 7 | 0.453 | 0.822 | 521 | 721 | 921 | 218.3 | 336.6 | 445.2 | 870.2 | 432.2 |
| 26 | AKSAY | | 4/M | 4 | 1 | IANT CISTERNAMAGN | 1 | 0.076 | 3.168 | 63.9 | 992.7 | 97.4 | 45.2 | 44.7 | 909 | 886.8 | 37.1 |
| 27 | FAREEZ | | 4/M | 4 | 1 | IANT CISTERNAMAGN | 1 | 0.069 | 3.1 | 56.8 | 994.6 | 98.1 | 26.2 | 36.8 | 936.8 | 883.3 | 39.1 |
| 28 | SELVAMURUGAN | | 35/M | 35 | 1 | CHOROIDAL FISSURE | 1 | 0.077 | 2.057 | 51.1 | 995 | 114.2 | 14.3 | 36 | 949.3 | 528.2 | 69.5 |
| 29 | SELVAKESAVAN | | 34/M | 34 | 1 | CHOROIDAL FISSURE | 1 | 0.156 | 2.59 | 128.9 | 973.3 | 124.6 | 55.2 | 95.6 | 849.2 | 442 | 34.6 |
| 30 | SATHYAGIRIRAJAN | | 75/M | 75 | 1 | CHOROIDAL FISSURE | 1 | 0.109 | 3.25 | 88.9 | 987.3 | 154 | 37 | 67.9 | 895.1 | 468.6 | 18.4 |
| 31 | JAYAPRADHA | | 7/F | 7 | 2 | CHOROIDAL FISSURE | 1 | 0.146 | 2.67 | 80.8 | 878.2 | 152.1 | 40.2 | 69.4 | 890.4 | 442.4 | 26.5 |
| 32 | KAAVIYA | | 1/F | 1 | 2 | CHOROIDAL FISSURE | 1 | 0.132 | 2.87 | 82.2 | 980.3 | 146.2 | 35.2 | 65.3 | 899.5 | 462.6 | 28.2 |
| 33 | HARISUDAS | | 4/M | 4 | 1 | CHOROIDAL FISSURE | 1 | 0.145 | 2.57 | 86.8 | 994 | 126.5 | 38.1 | 68.2 | 893.7 | 432.2 | 31.8 |
| 34 | ANIRUDH J SHETTY | | 26/M | 26 | 1 | EPENDYMAL CYST | 1 | 0.089 | 2.199 | 76.2 | 989.4 | 129.4 | 39.4 | 67.8 | 892.8 | 550.6 | 26.2 |
| 35 | JAYASHREE | | 1/F | 1 | 2 | EPENDYMAL CYST | 1 | 0.092 | 3.1 | 75.6 | 990.2 | 130.5 | 33.3 | 53.4 | 913.3 | 570.9 | 24.2 |
| 36 | NAVEEN | | 20/M | 20 | 1 | NEUROGLIAL CYST | 1 | 0.16 | 1.555 | 138 | 969.8 | 241.5 | 56.3 | 104.8 | 838 | 559.5 | 118.3 |
| 37 | SAKUNTHALA | | 52/F | 52 | 2 | NEUROGLIAL CYST | 1 | 0.012 | 3.1 | 98.8 | 983 | 167 | 54.1 | 46.3 | 899.7 | 605.1 | 25.9 |
| 38 | LOKESH | | 13/M | 13 | 1 | NEUROGLIAL CYST | 1 | 0.088 | 3.1 | 72.7 | 991 | 126 | 30.1 | 54.5 | 915.4 | 685 | 30.1 |
| 39 | AMUDHA | | 32/F | 32 | 2 | ABSCESS | 6 | 0.048 | 0.5 | 38.8 | 997 | 61.9 | 10.3 | 31 | 958.7 | 530.2 | 291.6 |
| 40 | CHEZHIAN | | 3/M | 3 | 1 | ABSCESS | 6 | 0.089 | 0.507 | 64.6 | 993 | 62.5 | 31.4 | 43.2 | 925.5 | 524.2 | 294.4 |
| 41 | YASMINE | | 17/F | 17 | 2 | ABSCESS | 6 | 0.076 | 1.77 | 62.8 | 993.8 | 108.8 | 25.5 | 50 | 924.5 | 815.8 | 141.8 |
| 42 | SUDAN | | 6/M | 6 | 1 | ABSCESS | 6 | 0.086 | 0.56 | 58.8 | 970 | 78.4 | 11.3 | 33.7 | 955 | 758.3 | 184.2 |
| 43 | KUMAR | | 22/M | 22 | 1 | ABSCESS | 6 | 0.091 | 0.55 | 59.2 | 990.6 | 82.2 | 9.7 | 29.3 | 961 | 626.5 | 287.7 |
| 44 | PURUSHOTHAMAN | | 87/M | 87 | 1 | SCHWANNOMA | 4 | 0.088 | 2.689 | 55.2 | 989.6 | 76.5 | 21.2 | 30.1 | 948.7 | 658.4 | 78.7 |
| 45 | JOELLE | | 8/F | 8 | 2 | CRANIOPHARYNGIOMA | 4 | 0.092 | 2.3 | 58.6 | 978.2 | 83.2 | 25.3 | 32.2 | 942.5 | 707.2 | 80.2 |
| 46 | MOIMIN ALI | | 8/M | 8 | 1 | CRANIOPHARYNGIOMA | 4 | 0.086 | 2.42 | 48.6 | 991.8 | 88.6 | 20.1 | 27.3 | 952.6 | 698.4 | 79.6 |
| 47 | SARAVANAN | | 48/M | 48 | 1 | POST OP CYST | 2 | 0.061 | 2.877 | 44.9 | 996 | 89.8 | 18.9 | 36.3 | 944.8 | 1016.4 | 55.5 |
| 48 | NAGAPPAN | | 36/M | 36 | 1 | POST OP CYST | 2 | 0.068 | 2.785 | 37.4 | 997 | 96.6 | 17.4 | 24.4 | 958 | 776.6 | 46.1 |
| 49 | NAGAPPAN | | 30/M | 30 | 1 | LOW GRADE ASTROCYTOMA | 4 | 0.078 | 2.891 | 63.5 | 993.5 | 90.3 | 18.6 | 35.1 | 946.3 | 776.9 | 46.5 |
| 50 | VARUN | | 3/M | 3 | 1 | LOW GRADE ASTROCYTOMA | 4 | 0.096 | 3.168 | 79.6 | 989 | 137.4 | 36.8 | 71.1 | 892.3 | 669 | 31.7 |
| 51 | RAMASUBRAMANIAM | | 66/M | 66 | 1 | GANGLIOGLIOMA | 4 | 0.083 | 2.943 | 75 | 991 | 123.4 | 33.2 | 43.8 | 923 | 576 | 30.6 |
| 52 | HASMATH FATHIMA | | 8/F | 8 | 2 | CHOROID PLEXUS CYST | 1 | 0.119 | 2.854 | 98.2 | 984.5 | 168.3 | 50.4 | 53.1 | 896.3 | 672.3 | 39.9 |
| 53 | B/O SANYA | | 1/M | 1 | 1 | CHOROID PLEXUS CYST | 1 | 0.112 | 2.852 | 96.4 | 983.5 | 169.1 | 48.4 | 52.1 | 900.3 | 670.1 | 40.3 |
| 54 | KOTHANDAPANI | | 60/M | 60 | 1 | METASTASIS | 5 | 0.058 | 2.8 | 47.5 | 996.3 | 82.4 | 18.4 | 38.8 | 942.9 | 731 | 43.9 |
| 55 | SOUNDARARAJAN | | 62/M | 62 | 1 | METASTASIS | 5 | 0.072 | 2.874 | 58.1 | 994.4 | 100.8 | 25.4 | 45.1 | 929.5 | 646 | 36.6 |
| 56 | RAMASUBRAMANIYAM | | 39/M | 39 | 1 | HIGH GRADE GLIOMA | 5 | 0.061 | 1.33 | 49.9 | 995.7 | 86.5 | 20.2 | 39.8 | 939.6 | 592 | 159.4 |
| 57 | RAJESHWARI | | 42/F | 42 | 2 | HIGH GRADE GLIOMA | 5 | 0.057 | 2.788 | 47.2 | 996.2 | 81.4 | 21.4 | 31.5 | 947.1 | 807.6 | 49.8 |
| 58 | SAI SANTHOSH | | 3/M | 3 | 1 | ASTROBLASTOMA | 5 | 0.054 | 2.7 | 44.3 | 996.7 | 76.9 | 18.7 | 32.8 | 948.4 | 791.8 | 50.5 |
| 59 | VIJAYA KUMAR | | 60/M | 60 | 1 | CYSTIC ENCEPHALOMALACIA | 2 | 0.052 | 2.977 | 44 | 996 | 189.9 | 20.7 | 27.7 | 951.6 | 680.9 | 28.8 |
| 60 | ARTHI H.SANI | | 47/F | 47 | 2 | RADIATION NECROSIS | 2 | 0.043 | 0.917 | 35.6 | 998 | 61.7 | 12.5 | 31.4 | 956 | 565 | 232 |
| 61 | GEORBEN SILVERA | | 29/M | 29 | 1 | GANGLIOGLIOMA | 4 | 0.081 | 2.842 | 76 | 997 | 125.4 | 35.4 | 45.9 | 918.7 | 570 | 31.5 |
| 62 | LINGESAN | | 11/M | 11 | 1 | CYSTIC ENCEPHALOMALACIA | 2 | 0.0565 | 3.062 | 45.6 | 996.3 | 76.2 | 18.7 | 35.2 | 946.1 | 702.7 | 32.9 |