Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-6 | November-December 2021
Page no- 43-52 | Section- Research Article (Radiology)

Role of Plain Computed Tomography in Evaluation of the Spectrum of Intracranial Calcification in Pediatric Population

Manu Srinivas Hunasanahalli[1], Shramana Bagchi[2]*, Ramesh Ramagatta Lakshmana Nayak[3], Vinodh Damala[4], Rashmi Devaraj[5]

[1]Assistant Professor, Indira Gandhi Institute of Child Health, Bangalore, Karnataka, India.
Email: manusrinivash@gmail.com
Orcid ID: 0000-0003-2539-2656
[2]Fellow, Department of Pediatric Radiology, Indira Gandhi Institute of Child Health, Bangalore, Karnataka, India,
Email: drshramanabagchi@gmail.com,
Orcid ID: 0000-0002-6070-5470
[3]Professor and Head, Indira Gandhi Institute of Child Health, Bangalore, Karnataka, India,
Email: drrameshrl18@gmail.com,
Orcid ID: 0000-0001-9463-6496
[4]Fellow, Department of Pediatric Radiology, Indira Gandhi Institute of Child Health, Bangalore, Karnataka, India,
Email: vinodhdnmc@gmail.com,
Orcid ID: 0000-0001-9200-8015
[5]Associate Consultant, Department of Neurology, Apollo Hospital, Bangalore, Karnataka, India.
Email: rashmid.326@gmail.com,
Orcid ID: 0000-0003-1493-5213
*Corresponding author

Received: 03 March 2021
Revised: 29 April 2021
Accepted: 08 May 2021
Published: 22 October 2021

Abstract

Background: Intracranial calcification (ICC) refers to calcification within the cranial cavity, and is most commonly represented by calcification within the parenchyma of the brain or its vasculature. Hence the present study was undertaken for assessing the role of plain computed tomography in evaluation of the spectrum of intracranial calcification in pediatric population. **Methods**: A total of 118 pediatric subjects were enrolled in the present study. A Proforma was made and complete demographic and clinical data of all the subjects was noted. CT findings were recorded in separate Proforma. All the results were recorded in Microsoft excel sheet and were subjected to statistical analysis. SPSS software was used for data assessment. **Results:** Out of 118 patients with intracranial calcification, physiologic calcification and pathologic calcification was seen in 22% percent and 78% percent of the patients respectively. Out of 26 patients with physiologic calcification, Dural, choroidal and habenular calcification was seen in 9.3% , 6.8% and 6% percent of the patients respectively. Among 78 patients with pathologic calcification, TORCH, Metabollic, Tuberus sclerosis and mineralising microangiopathy were seen in 32%, 13.5 %, 10.1 % and 5.0 % respectively Non-significant results were obtained while correlating Age and gender-wise distribution of patients with different intracranial calcification. **Conclusions:** It can be concluded that plain computed tomography is an important modality in the evaluation of pediatric intracranial calcifications. It can help differentiate physiologic from pathologic calcifications. Based on the location, pattern and morphology of the calcification and with relevant clinical information, it is possible to arrive at an accurate etiology.

Keywords:- Intracranial calcification, Pediatric.

INTRODUCTION

Intracranial calcification (ICC) refers to calcification within the cranial cavity, and is generally taken to mean calcification within the parenchyma of the brain or its vasculature. The term physiological calcification is used to indicate calcification when seen as part of normal ageing. It is arguable whether physiological calcification occurs anywhere

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-6 | November-December 2021
Page no- 43-52 | Section- Research Article (Radiology)

other than in the pineal gland or choroid plexus. Therefore, with the exception of calcification in these areas, which rarely manifests in the first two decades of life, ICC occurring before the age of 20 years can be regarded as pathological.[1,2,3]

Calcification may be demonstrated by plain film skull radiography, ultrasound, CT imaging and magnetic resonance imaging. The sensitivity and specificity for the identification of ICC differs according to imaging modality, intra-modality technique, and the age of the patient.[4,5,6]

The problem of differentiation between ICC and haemorrhage is not limited to ultrasound, but is also relevant to CT imaging. CT has been the imaging mainstay for the demonstration of ICC for many years. Even with the advent of MRI in the early 1990s, CT remains superior for the identification and delineation of ICC. On CT, ICC appears as areas of high density, with a comparable Hounsfield unit value to bone. However, it is not possible to unequivocally distinguish between haemorrhage and ICC in a single CT image. Follow-up imaging that demonstrates a change in appearance of a high-density focus is supportive, but not definitive, of the appearance being the result of haemorrhage.[4,5,6,7]

The present study was undertaken for assessing the role of plain computed tomography in evaluation of the spectrum of intracranial calcification in pediatric population.

MATERIAL AND METHODS

The present study was conducted in the department of Pediatric Radiology with the aim of assessing the role of plain computed tomography in evaluation of the spectrum of intracranial calcification in pediatric population. All the pediatric subjects who came for CT brain were enrolled for the present study.

Inclusion criteria:

- Subjects within the age range of 1 day to 18 years
- Subjects who were referred for CT brain due to any cause
- Informed consent of the parents/guardians was available

Exclusion criteria was :

- Subjects with presence of debilitating condition in whom CT could not be done.
- Subjects in which informed consent was not available.

A Proforma was made and complete demographic and clinical data of all the subjects was noted. CT findings were recorded in separate Proforma. All the results were recorded in Microsoft excel sheet and were subjected to statistical analysis. SPSS software was used for data assessment.

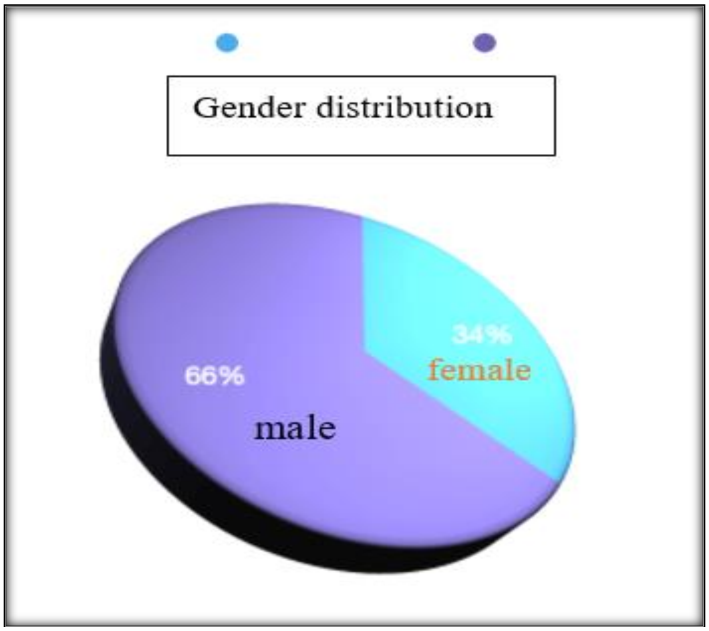
Univariate regression curve and Chi-square test were used for evaluation of level of significance.

RESULTS

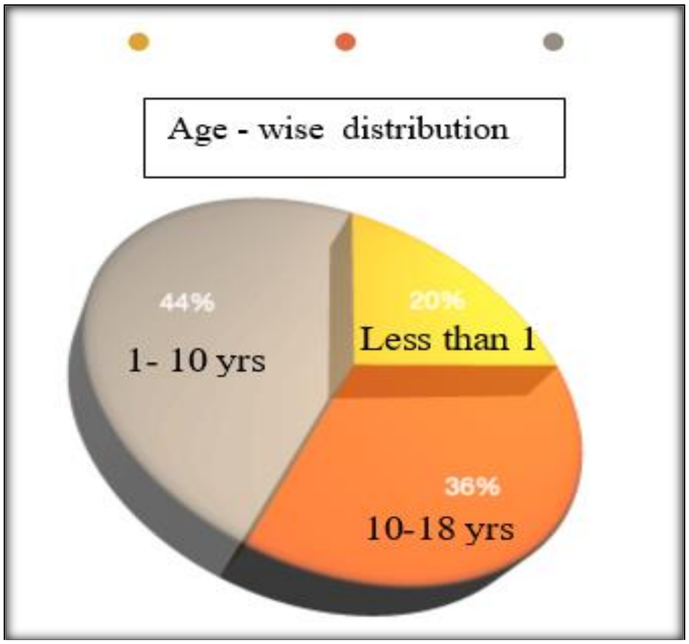
A total of 118 cases were taken into account. 70 were males while the remaining 55 were females. Mean age of the subjects with intracranial calcification was 13.6 years. Out of 118 patients with intracranial calcification, physiologic calcification and pathologic calcification was seen in 22% percent and 78% percent of the patients respectively. Out of 26 patients with physiologic calcification, Dural,

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-6 | November-December 2021
Page no- 43-52 | Section- Research Article (Radiology)

choroidal and habenular calcification was seen in 9.3% , 6.8% and 6% percent of the patients respectively. Among 78 patients with pathologic calcification, TORCH, Metabolic, Tuberous sclerosis and mineralising microangiopathy were seen in 32%, 13.5 %, 10.1 % and 5.0 % respectively. Non-significant results were obtained while correlating Age and gender-wise distribution of patients with different intracranial calcification.



Graph 1: Incidence of intracranial calcification



Graph 2: Age wise distribution of intracranial calcification

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-6 | November-December 2021
Page no- 43-52 | Section- Research Article (Radiology)

Table 1: Demographic data of subjects with intracranial calcification

Variable		Number of patients	Percentage
Age group (years)	Less than 1	24	20.34
	1 to 10	42	35.59
	10.01 to 18	52	44.07
Gender	Males	78	66.10
	Females	40	33.90

Table 2: Spectrum of intracranial calcification

Intracranial calcification		Number of patients	Percentage
Physiologic	Dural	11	9.3
	Choroidal	8	6.8
	Habenula	7	6
	Total physiologic	26	22
Pathologic	TORCH	38	32
	Metabollic	16	13.5
	Tuberus sclerosis	12	10.1
	Mineralising angiopathy	6	5.0
	Others	20	17
	Total	92	78

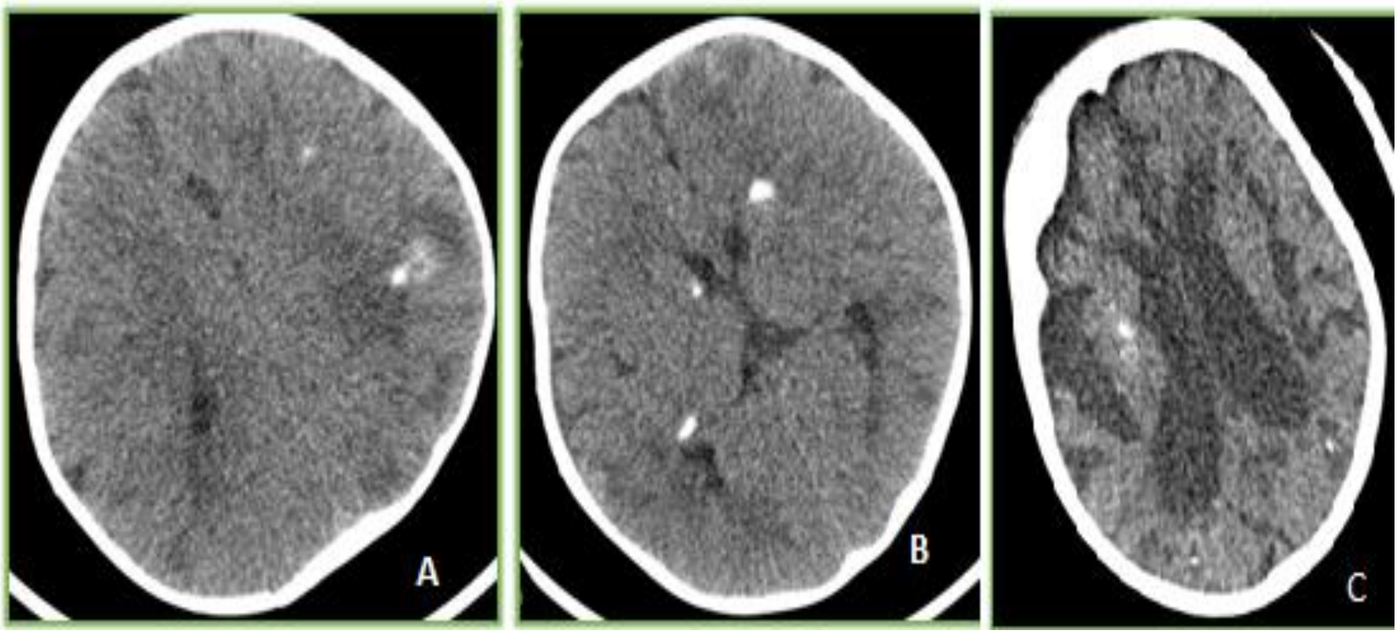


Figure 1: Torch; Nonenhanced CT scan in :a,b) 1-year old child , shows calcifications in bilateral periventricular and left parietal region. c) 2-year old child , shows atrophy of the brain parenchyma with chunky calcifications in right insular cortex and left parietal region.

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-6 | November-December 2021
Page no- 43-52 | Section- Research Article (Radiology)

Figure 2: Nonenhanced CT scan in a 3-year old child, shows linear calcification in left parietal region. Diagnosed as mineralizing microangiopathy.

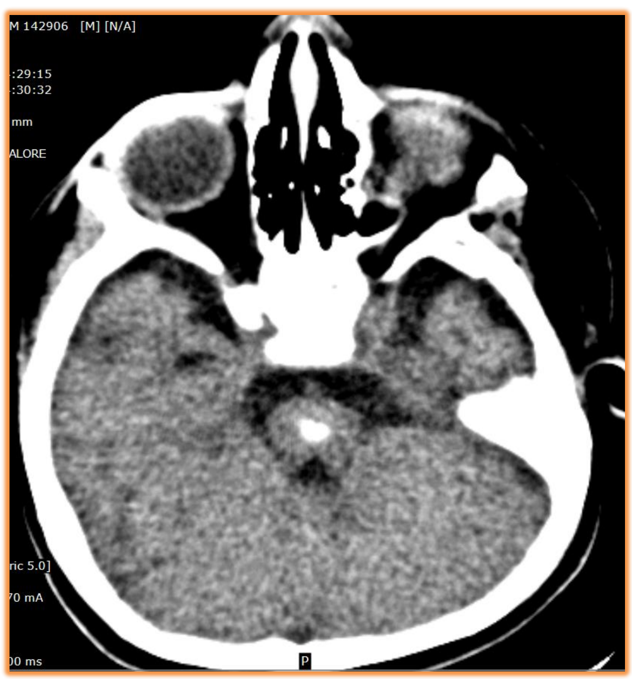


Figure 3: Nonenhanced CT scan in a 4-year old known case of hypothyroidism , shows calcification in pons region.

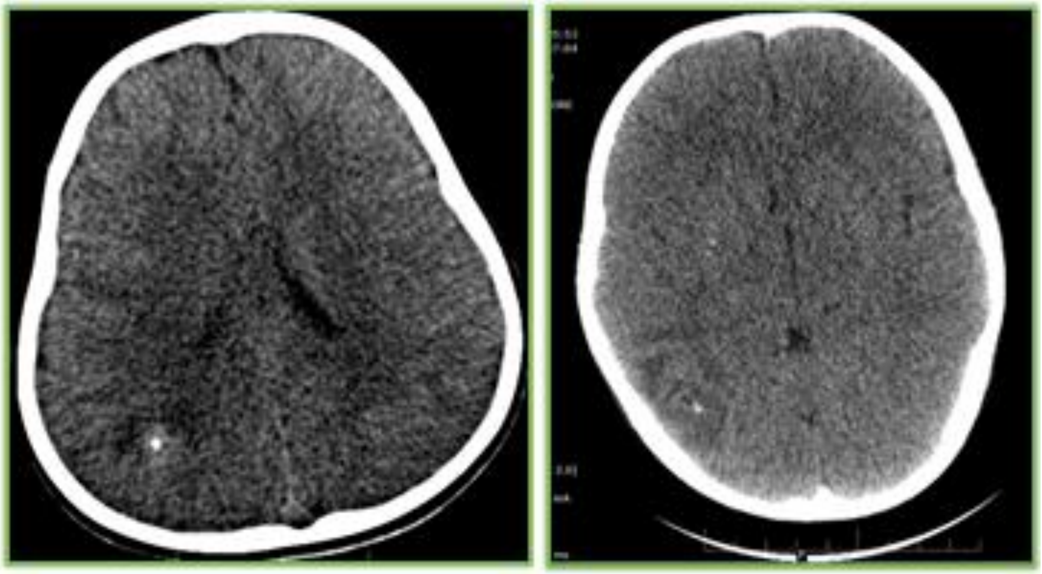


Figure 4: a) Nonenhanced CT scan in a) 5-year old child with seizures, shows calcified neurocysticercosis in right parietal region. b) 9-year old child with seizures, shows calcified neurocysticercosis with profuse perilesional edema in right parietal region.

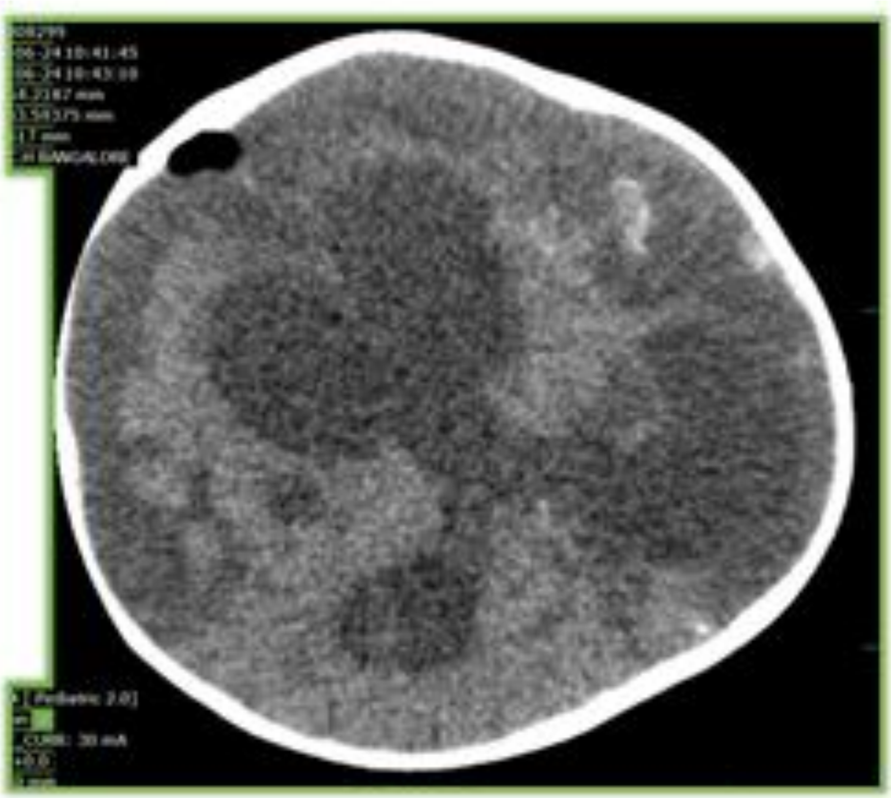


Figure 5: 18 month old child , shows atrophy of the brain parenchyma with hydrocephalous . There is dystrophic calcifications in left insular cortex and parietal region. There is focal pneumocephalous.

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-6 | November-December 2021
Page no- 43-52 | Section- Research Article (Radiology)

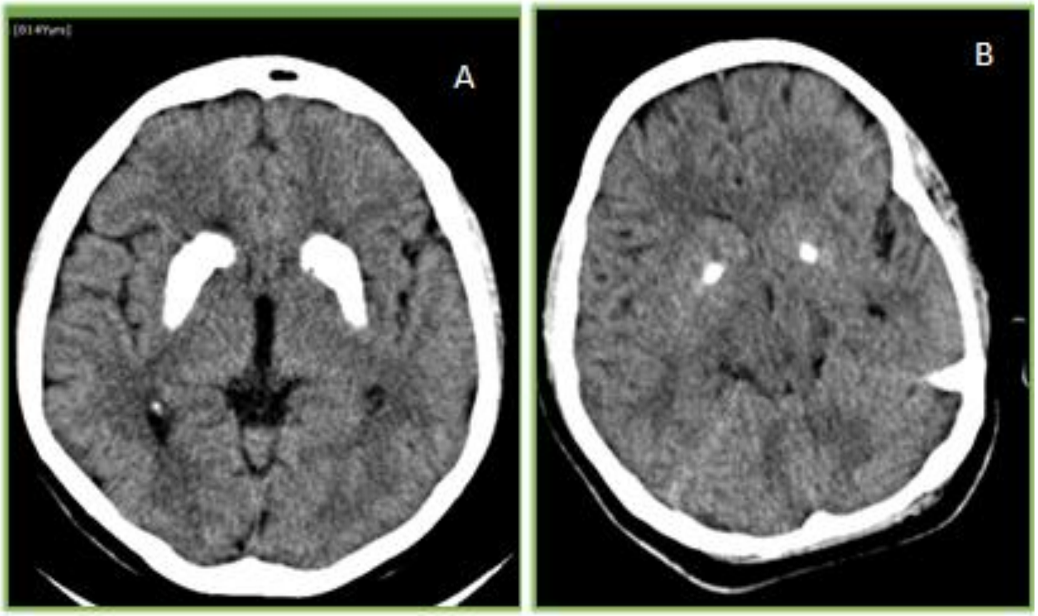


Figure 6: Fahr's Disease. a. 24 month old child, shows profuse bilateral basal ganglia calcifications b. 4- year old child shows focal bilateral basal ganglia calcifications.

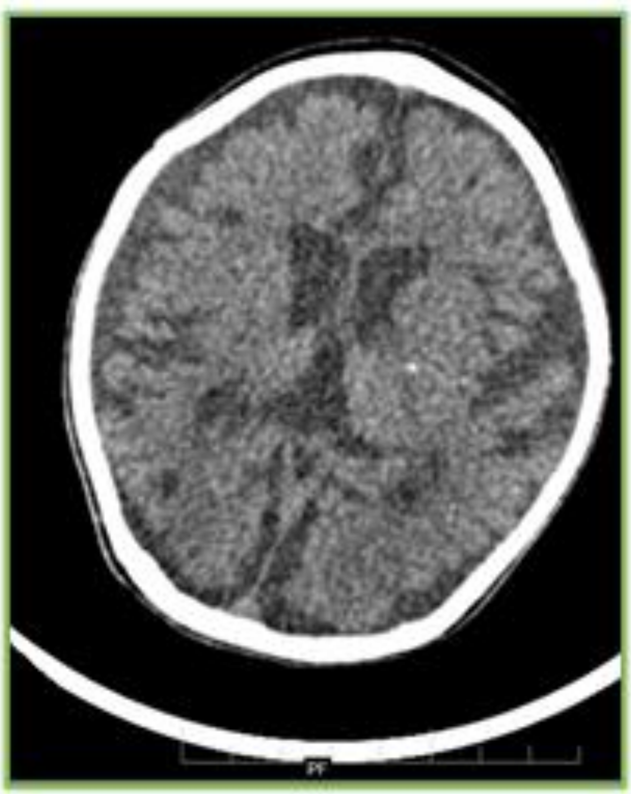


Figure 7: 18 month old child, shows atrophy of the brain parenchyma. There is focal left basal ganglia calcifications, Biochemical evaluation proves Glutaric aciduria.

DISCUSSION

Intracranial calcifications refer to calcifications within the brain parenchyma or vasculature. The usage of Computed Tomography scans has largely contributed in the accurate detection, localization and classification of intracranial calcifications. Even with the introduction of Magnetic Resonance Imaging in the 1990s, CT scan yet proved to be superior in the detection and characterization of brain calcifications. IC includes physiologic/age-related calcifications and a wide spectrum of pathological calcifications. Nonetheless, previous studies were successful in linking various IC based on their radiological phenotype to specific pathological conditions.[8,9,10] Hence; in the light of above mentioned data, the present study was undertaken for assessing the role of plain computed tomography in evaluation of the spectrum of intracranial calcification in pediatric population.

In the present study, intracranial calcification was seen in 118 patients. Among these 118 subjects, 78 were males and 40 were females. Mean age of the subjects with intracranial calcification was 13.6 years. Out of 118 patients with intracranial calcification, physiologic calcification and pathologic calcification was seen in 61.02 percent and 38.98 percent of the patients respectively. Our results were in concordance with the results obtained by previous authors who also reported similar findings in their studies. In a study done by Whitehead et.al on 500 pediatric subjects, a total of 40% (202/500 study subjects) were found to have physiologic calcifications with 97% being older than 5 years of age. Interestingly, calcifications were found to be more common in the choroid plexus (58/500) followed by the habenula (50/500) and pineal gland (25/500).[11]

In the pediatric population, a spontaneous intimal tear or dissection may lead to the formation of an intracranial aneurysm. Intracranial aneurysms are found to be calcified in around 20% of the cases. Indeed, marginal calcifications first form after the intimal tear and are then followed by the formation of a sheet-like calcific plaque. In a study that involved 33 pediatric patients, aneurysms greater or equal to 10 millimeters were found to be calcified in contrast to ruptured aneurysms, implicating that calcified aneurysms tend be more stable than uncalcified ones.[12]

In the present study, out of 118 patients with intracranial calcification, physiologic calcification and pathologic calcification was seen in 22% percent and 78% percent of the patients respectively. Out of 26 patients with physiologic calcification, Dural, choroidal and habenular calcification was seen in 9.3% , 6.8% and 6% percent of the patients respectively. Among 78 patients with pathologic calcification, TORCH, Metabollic, Tuberus sclerosis and mineralising microangiopathy were seen in 32%, 13.5 %, 10.1 % and 5.0 % respectively.

In a study done by Lingappa et.al, 22 out of 23 children (mean age of 11 months) with basal ganglia ischemic stroke were found to have mineralization of the lenticulostriate arteries on CT scan. In fact, 18 had mild head trauma prior to the onset of stroke whereas the remaining of the cohort had no predisposing factors with no demonstrable causes of vascular or soft tissue calcifications.[13] Our results were also in

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-6 | November-December 2021
Page no- 43-52 | Section- Research Article (Radiology)

concordance with the results obtained by Kendall B et al who also reported similar findings. In their study, authors examined computed tomograms of 18000 children consecutively form the basis of an assessment of the diagnostic significance of intracranial calcification. The low incidence of physiological calcification in the pineal and choroid of about 2% up to the age of 8 years, but increasing 5-fold by the age of 15 years, is confirmed. Pathological calcification occurred in 1.6%. Diffuse basal ganglia calcification (15%) bore little relation to the diverse clinical symptomatology, and routine biochemical studies showed a disorder of metabolism to be present in only 6 cases. Calcification has not been previously noted in acute haemorrhagic leukoencephalitis, Pertussis or Cocksackie encephalitis, infantile neuraxonal dystrophy, Marinesco-Sj6gren syndrome or in the basal ganglia in neurofibromatosis.[14]

In the present study, non-significant results were obtained while correlating age and gender-wise distribution of patients with different intracranial calcification. In a recent review by Gonçalves FG et al. authors summarized the spectrum of intracranial calcifications in children. Intracranial calcification can be either physiological or pathological. Physiological intracranial calcification is not an expected neuroimaging finding in the neonatal or infantile period but occurs, as children grow older, in the pineal gland, habenula, choroid plexus and occasionally the dura mater. Pathological intracranial calcification can be broadly divided into infectious, congenital, endocrine/metabolic, vascular and neoplastic. Age at presentation, intracranial calcification location, and associated neuroimaging findings are useful information to help narrow the differential diagnosis of intracranial calcification. Intracranial calcification can occur in isolation or in association with other neuroimaging features. Intracranial calcification in congenital infections has been associated with clastic changes, hydrocephalus, chorioretinitis, white matter abnormalities, skull changes and malformations of cortical development. Infections are common causes of intracranial calcification, especially neonatal TORCH (toxoplasmosis, other [syphilis, varicella-zoster, parvovirus B19], rubella, cytomegalovirus and herpes) infections.[15] Dugan SL et al described 2 children in whom the presence and pattern of intracranial calcifications led to the diagnosis of uncommon genetic disorders, Adams-Oliver syndrome and Aicardi-Goutieres syndrome. Differentiating genetic conditions from intrauterine infections or other causes of intracranial calcifications enables practitioners to provide accurate counseling regarding prognosis and recurrence risk.[16] E G Grant et al reported the sonographic and computed tomography (CT) findings in seven infants and neonates with intracranial calcifications and a spectrum of underlying disorders, including toxoplasmosis, cytomegalic inclusion disease, transverse/straight sinus thrombosis, and probable anoxia. Neurotropic infectious disease usually produced clumped or subependymal calcifications accompanied by sometimes bizarre ventricular configurations and prominent periventricular cystic encephalomalacia. Sonography failed to identify prospectively intracranial calcifications in two of the three patients without infection, although calcifications were visible in retrospect. Overall, CT provided optimum visualization of intracranial calcifications.[17]

CONCLUSIONS

It can be concluded that plain computed tomography is an important modality in the evaluation of pediatric intracranial calcifications. It can help differentiate physiologic from pathologic calcifications. Pathologic calcifications are more common than physiologic calcifications in the pediatric age group. Based on the location, pattern and morphology of the calcification, a pattern recognition can be deciphered and with relevant clinical information, it is possible to arrive at an accurate etiology.

REFERENCES

1. Deng H, Zheng W, Jankovic J. Genetics and molecular biology of brain calcification. Ageing Res Rev. 2015;22:20-38. doi: 10.1016/j.arr.2015.04.004.
2. Yalcin A, Ceylan M, Bayraktutan OF, Sonkaya AR, Yuce I. Age and gender related prevalence of intracranial calcifications in CT imaging; data from 12,000 healthy subjects. J Chem Neuroanat. 2016;78:20-24. doi: 10.1016/j.jchemneu.2016.07.008.
3. Grech R, Grech S, Mizzi A. Intracranial calcifications. A pictorial review. Neuroradiol J. 2012;25(4):427-51. doi: 10.1177/197140091202500406.
4. Bignami A, Appicciutoli L. Micropolygyria and calcification in cytomegalic inclusion disease. Acta Neuropathol 1964; 4: 127– 37.
5. Lago EG, Baldisserotto M, Hoefel Filho JR, Santiago D, Jungblut R. Agreement between ultrasonography and computed tomography in detecting intracranial calcifications in congenital toxoplasmosis. Clin Radiol 2007; 62: 1004– 11.
6. Go JL, Zee CS. Unique CT imaging advantages. Hemorrhage and calcification. Neuroimaging Clin N Am. 1998;8:541–58.
7. Tonduti D, Panteghini C, Pichiecchio A, et al. Encephalopathies with intracranial calcification in children: clinical and genetic characterization. Orphanet J Rare Dis. 2018;13(1):135. Published 2018 Aug 16. doi:10.1186/s13023-018-0854-y
8. Cohen S. N, Friedlander A. H, Jolly D. A. Carotid calcification on panoramic radiographs: an important marker for vascular risk. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002;94:510-514.
9. Ptak T, Hunter G. H, Avakian R. Clinical significance of cavernous carotid calcification encountered on head computed tomography scan performed on patient seen in the emergency department. J comput Assist Tomogr. 2003; 27: 505-509.
10. Bergevin MA, Daugherty CC, Bove KE, McAdams AJ. The internal carotid artery siphon in children and adolescents. Hum Pathol. 1991;22(6):603-6. doi: 10.1016/0046-8177(91)90239-l.
11. Whitehead MT, Oh C, Raju A, Choudhri AF. Physiologic pineal region, choroid plexus, and dural calcifications in the first decade of life. AJNR Am J Neuroradiol. 2015;36(3):575-80. doi: 10.3174/ajnr.A4153.
12. Saade C, Najem E, Asmar K, Salman R, El Achkar B, Naffaa L. Intracranial calcifications on CT: an updated review. J Radiol Case Rep. 2019;13(8):1-18. doi:10.3941/jrcr.v13i8.3633
13. Lingappa L, Varma RD, Siddaiahgari S, Konanki R. Mineralizing angiopathy with infantile basal ganglia stroke after minor trauma. Dev Med Child Neurol. 2014;56(1):78-84. doi: 10.1111/dmcn.12275.
14. Kendall B, Cavanagh N. Intracranial calcification in paediatric computed tomography. Neuroradiology. 1986;28(4):324-30. doi: 10.1007/BF00333438.
15. Gonçalves FG, Caschera L, Teixeira SR, Viaene AN, Pinelli L, Mankad K, et al. Intracranial calcifications in childhood: Part 1. Pediatr Radiol. 2020;50(10):1424-1447. doi: 10.1007/s00247-020-04721-1.
16. Dugan SL, Botto LD, Hedlund GL, Bale JF Jr. Intracranial Calcifications in Young Children. Semin Pediatr Neurol. 2018 Jul;26:135-139. doi: 10.1016/j.spen.2017.03.022.
17. E G Grant, A L Williams, D Schellinger, T L Slovis. Intracranial calcification in the infant and neonate: evaluation by sonography and CT. Radiology. 1985;157(1). https://doi.org/10.1148/radiology.157.1.2994172

Source of Support: Nil, Conflict of Interest: None declare