Research Article

EVALUATION OF PHYSIOLOGICAL AND PATHOLOGICAL INTRACRANIAL CALCIFICATION'S ON COMPUTED TOMOGRAPHY

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Abstract :

Aims and Objectives: To study the location, size, number, pattern and incidence of calcification in various intracranial conditions, both physiological and pathological.**Materials and Methods:** This is a prospective study of 100 patients which were referred to our department from other departments with intracranial physiological and pathological calcifications over a period of 24 months. Unenhanced CT of the brain was performed for these patients in the axial plane, complemented by coronal & sagittal 3D reconstruction with contrast study in selected cases. **Results:** Intracranial calcifications both physiological and pathological are more common in males than females. The pineal gland has highest incidence in the sample data by 78%(71.8 %), the pineal gland scored high degree of calcification by mean of CT number value 192.7 HU followed by choroid plexus by 75 % (66.2 %). Habenula had 18 % (20.1 %) of calcification, Tentorium & falx had 8 %(7.3) and age related basal ganglia calcification 3%(0.5-4 %).The highest incidence of pathological calcification is found in the age group of more than 40 years with infection's (granulomas) having the highest incidence of 48% . Tumours had 40 %, vascular lesions had 6%, pathological bilateral basal ganglia had 4 % and congenital phakomatoses in 2% of patients **.Conclusion**: Intracranial calcification is a marker of present or past disease and age related conditions .With advent of CT, calcifications were not only easy to appreciate and demonstrate but also several morphological patterns have helped to correlate the types of calcification of the disease process.\

Key words: Intracranial calcifications; Age-related Physiological; Pathological; Computed Tomography (CT); Magnetic Resonance Imaging (MRI), Cerebrospinal Fluid (CSF)

INTRODUCTION

Intracranial calcifications are often due to calcium and sometimes iron deposition in the blood vessels of different structures of the brain. They can occur both in normal and abnormal cranial tissues. Calcium usually deposits in the medial layer of cranial blood vessels[1]. Intracranial calcifications may be physiological or pathological.

Physiological calcifications are unaccompanied by any evidence of disease and have no demonstrable pathological cause. They include calcifications of the pineal gland, habenula, choroid plexus, falx, and some idiopathic calcifications in the basal ganglia, vessel walls, sagittal sinus, lens and other non-defined areas. There is spectrum of common and uncommon calcification that associated with pathology but the normal calcification (Physiologic Calcification) are very common and have been well described in the past decades.

Pathological calcification is a marker of present or past intra cranial disease. It is radiological challenge to appreciate and demonstrate such markers. With advent of CT calcifications were not only easy to appreciate and demonstrate but also several morphological patterns have helped to correlate the types of calcification of the disease process. They include Posttraumatic and dystrophic, Congenital disorders (phakomatoses), vascular disorders Infections, Inflammatory disorders, Tumors and metabolic disorders

Simple radiography, computed tomography (CT), magnetic resonance imaging (MRI) and, for infants, sonography all help physicians in the diagnosis of intracranial calcifications, but CT has a high sensitivity in diagnosis because of the hyperdense signals of calcifications in this tomography.

AIMS AND OBJECTIVES

1. To study the computed tomography (CT) findings of various physiological and pathological intracranial calcification
2. To distinguish between the physiological from the pathological intracranial calcification.
3. To characterize the type of calcifications in specific diseases / conditions.

MATERIAL AND METHODS:

We included all patients who were referred for CT scan of brain during a period of 24 months from November 2011 to October 2013. Unenhanced CT scan of the PNS was performed for 100 patients in the axial plane **"GE single slice spiral CT machine" & SIEMENS SOMATOM Emotion, 16 slice MDCT** w**ith coronal and sagittal 3D reconstruction in necessary cases.**

For axial studies, patients were put in supine position. Taking the orbito-meatal line as reference axis, the plane of section was parallel to this line. Direct scans 5 mm in thickness were made, from the orbito-meatal line to the outer table of the parietal bone. For the coronal and sagittal, which were 2.5 mm thick, 3D reconstructed images were used. The exposure settings used were 130 kVp and 80 to 100 mAs.

Pregnant women and patients with history of RTA, or past h/o surgery in the head such post-craniotomy were not included in this study.

In all cases, systematic studies of the brain were performed in axial sections complemented by coronal and sagittal views in selected cases.

In all cases, the existence of the calcification was investigated: (1) physiological and pathological calcification; (2) calcification according to the age of the patient ; (3) intra-axial or extra-axial in location ; (4) calcification within the tumour , Granulomatous disease , vascular & in the metabolic / endocrinal disease ; (5) type of calcification based on the appearance of the calcification. Associated findings with brain were also investigated which may lead in proper evaluation of the disease.

Statistical data analysis: Chi- square test and student's t-test was used for data analysis.

RESULTS

During the period of 24 months of the study 100 patients who fulfilled inclusion criteria were studied, out of which 54 were male and 46 were female **(Table-1).** Of the 100 cases studied, majority patients were in the age group of 10-74 yrs **(Table-2).**

CT scan detection of intracranial calcification (TABLE–3 TO 11): Intracranial calcifications both physiological and pathological are more common in males than females. The pineal gland has highest incidence in the sample data by 78%(71.8 %), the pineal gland scored high degree of calcification by mean of CT number value 192.7 HU followed by choroid plexus by 75 % (66.2 %). Habenula had 18 % (20.1 %) of calcification, Tentorium & falx had 8 %(7.3) and age related basal ganglia calcification 3%(0.5-4 %).The highest incidence of pathological calcification is found in the age group of more than 40 years with infection's (granulomas) having the highest incidence of 48% . Tumours had 40 %, vascular lesions had 6%, and pathological bilateral basal ganglia had 4 % and congenital phakomatoses in 2% of patients. Chi-square value for intracranial calcification is 21.4 and p-value for this is less than 0.05 indicating highly association.

Intracranial pathological calcification granulomas(46 %), meningioma(22 %), Glioma's(12 %), Craniopharyngioma(4%), Medulloblastoma(2%), AVM(2%), Aneurysm(2%), Congenital/Phakomatoses(2%), Bilateral Basal Ganglia Calcification (4%) in patients.(**Table-6 & 7**).

The following tables present the patient data, and the correlations between the sample age and the site of calcifications in the pineal gland, choroid plexus (left ventricle & right ventricle), falx cerebri, and habenula .

TABLE NO 1:- INCIDENCE OF CASES WITH PHYSIOLOGICAL INTRACRANIAL CALCIFICATION ACCORDING TO SEX

GENDER	NUMBER	PERCENTAGE
Male	54	54 %
Female	46	46 %
Total	100	100%

TABLE NO 2:- INCIDENCE OF CASES WITH PHYSIOLOGICAL INTRACRANIAL CALCIFICATION ACCORDING TO AGES

AGES	NUMBER	PERCENTAGE
10-24	22	22%
25-34	24	24%
35-44	22	22%
45-54	18	18%
55-64	06	6%
65-74	08	8%
Total	100	100%

TABLE NO 3:- INCIDENCE OF CASES WITH PHYSIOLOGICAL INTRACRANIAL CALCIFICATION SITES WITH AGES

AGES	PINEAL	RT VENTRICLE	LT VENTRICLE	HABENULA	FALX
14-24	18	14	14	0 6	02
25-34	16	20	20	06	04
35-44	22	20	20	0	02
45-54	14	14	14	04	0
55-64	04	04	04	0	0
65-74	04	04	02	02	0
Total	78	76	74	18	08

TABLE NO 4:- INCIDENCE OF CASES WITH PATHOLOGICAL INTRACRANIAL CALCIFICATION ACCORDING TO SEX

GENDER	NUMBER	PERCENTAGE
Male	54	54 %
Female	46	46 %
Total	100	100%

TABLE NO 5: - INCIDENCE OF CASES WITH PATHOLOGICAL INTRACRANIAL CALCIFICATION ACCORDING TO AGE

S.L NO	**AGE GROUP IN YEARS**	**NO OF CASES**	**PERCENTAGE**
1	< 10	32	32
2	10- 40	28	28
3	>40	40	40
		100	100

TABLE NO 6:- SUMMARY OF CASES WITH PATHOLOGICAL CALCIFICATION

SL.NO	**DIAGNOSIS**	**NO OF CASES**	**PERCENTAGE**
1	Infections	48	48%
2	Tumours	40	40%
3	Vascular	06	06%
4	Basal ganglia calcification	04	04%
5	Phakomatoses	02	02%
TOTAL		100	100%

TABLE 07:- INCIDENCE OF PATHOLOGICAL CALCIFICATION IN INDIVIDUAL CASES

SL.NO	DIAGNOSIS	NO OF CASES	PERCENTAGE
1	Granulomas	46	46 %
2	Toxoplasmosis	02	02 %
3	Meningioma	22	22 %
4	Gliomas	12	12 %
5	Carniopharyngioma	04	04 %
6	Medulloblastoma	02	02 %
7	AVM	02	02 %
8	Aneurysm	02	02 %
9	phakomatoses	02	02 %
10	Bilateral basal ganglia calcification	04	04 %
TOTAL		100	100 %

TABLE 08:- INCIDENCE OF CALCIFICATION IN GRANULOMA

SL.NO	GRANULOMAS	NO OF CASES	PERCENTAGE
1	Tuberculoma	40	86.96 %
2	Neurocysticercosis	06	13.04 %
TOTAL		46	100 %

TABLE 09:- INCIDENCE OF CALCIFICATION IN GLIOMAS

SL.NO	GLIOMAS	NO OF CASES	PERCENTAGE
1	Choroid plexus palilloma	04	33.33 %
2	Ependymoma	02	16.66 %
3	Glioblastoma multiforme	02	16.66 %
4	Oligodendroglioma	02	16.66 %
5	Pilocytic astrocytoma	02	16.66 %

ABLE NO 10 :- ICIDENCE BASED ON SIZE OF CALCIFICATION

SL.NO	DIAGNOSIS	< 1 cm	>1 cm
1	Granuloma	40	06
2	Meningioma	12	10
3	Gliomas	04	08
4	Craniopharyingioma	02	02
5	Toxoplasmaosis	---	02
6	phakomatoses	---	02

TABLE NO 11:- ICIDENCE BASED ON PATTERN OF DISTRIBUTION OF CALCIFICATION ON CT

SL.NO	DIAGNOSIS	Amorphous	Punctate	Linear	Nodular
1	Granulomas	----	----	----	46
2	Meningioma	08	10	10	12
3	Glioma	----	08	04	12
4	Craniopharyngioma	----	02	02	02
5	Bilateral basal ganglia calcification	02	02	02	----
6	Toxoplasmosis	----	02	02	02
7	AVM	----	----	02	02
8	Aneurysm	----	----	02	----
9	phakomatoses	----	----	02	02
10	Medulloblastoma	----	----	02	----
TOTAL		10	24	26	78

FIGURE NO:-1 Axial non enhanced CT brain images shows bilateral choroid plexus (arrowheads), pineal (arrow) and habenular calcification (dashed arrow)

FIGURE NO:-2 Axial non enhanced CT brain images shows age related physiological calcifications in bilateral basal ganglia

FIGURE NO:-3 Axial non enhanced CT brain images shows) shows calcified falx cerebri on the antero-posterior axis.

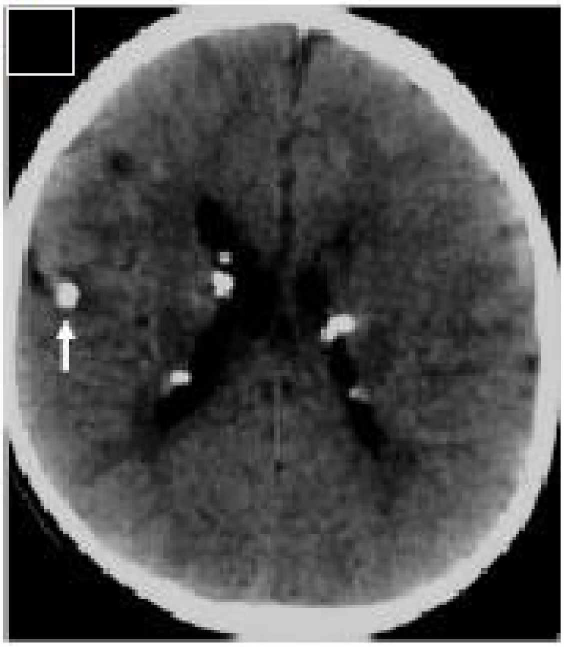

FIGURE NO:-4 and 5 Axial non enhanced CT brain images shows periventricular calcifications of sub-ependymal nodules and calcification of the subcortical nodule in two different patients with tuberous sclerosis

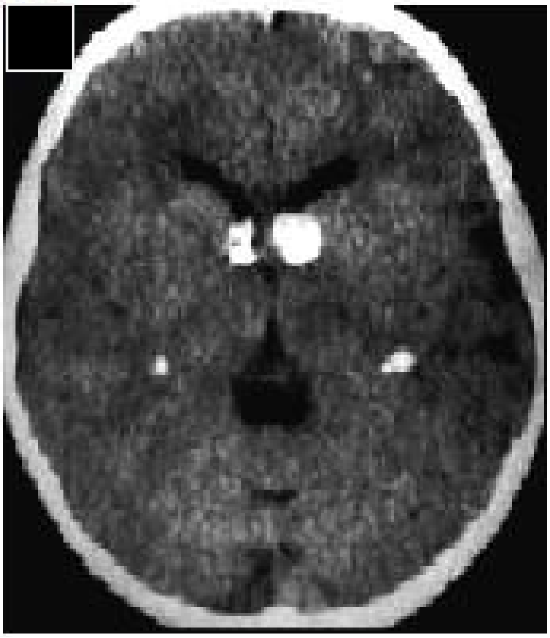

FIGURE NO: - 5 Axial non contrast enhanced CT brain shows characteristic of Fahr's Disease calfications of bilateral basal ganglia d head of caudate nucleus-

FIGURE NO:-6 Axial non contrast enhanced CT brain shows characteristic gyral calcification in strug-weber syndrome associated with atrophy of the right frontal and temporal lobes.

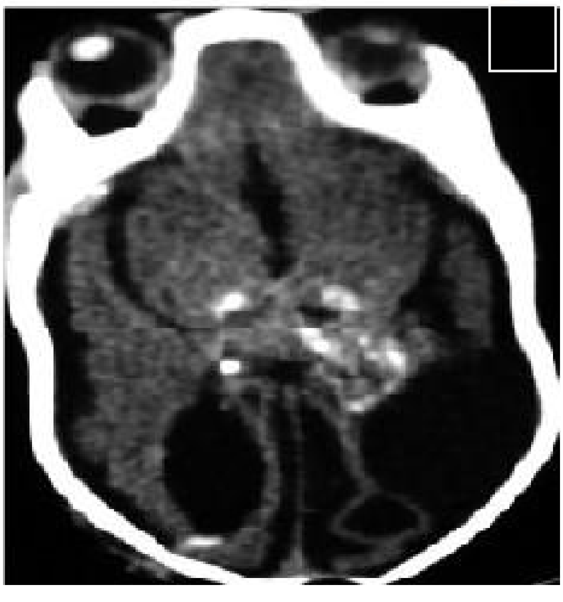

FIGURE NO: - 7 Axial non contrast enhanced CT brain shows extensive bilateral thalamic and Periventricular calcification associated with dilated ventricular asymmetry in congenital Toxoplasmosis

FIGURE NO: - 8 Axial non contrast enhanced CT brain shows extensive periventricular and Sub-ependymal calcifications with marked hydrocephaly in congenital cytomegalovirus infection

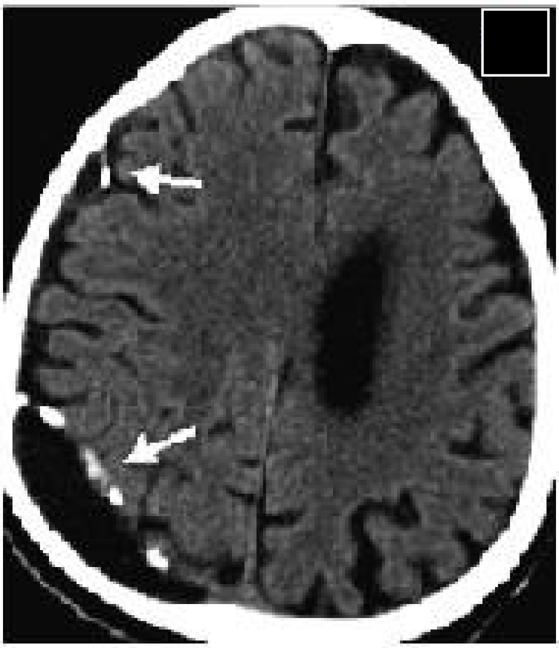

FIGURE NO: - 9 Axial non contrast enhanced CT brain shows unenhanced CT image shows low-density epidural effusions with calcified walls (arrows) adjacent to the right parietal lobe in patient of Congenital CMV

DISCUSSION

Intracranial calcifications seen on computed tomography (CT) are the most common finding in the everyday practice of radiology, because non contrast-enhanced CT of the head is the preferred imaging modality worldwide for the initial evaluation of patients with acute or chronic neurological problems.

Physiological calcifications are unaccompanied by any evidence of disease and have no demonstrable pathological cause.

According to the results obtained by M.H. Daghighi S et al[1] , the most common sites of intracranial physiological calcification areas are the following: 71.0% pineal calcification, 66.2% choroid plexus calcification, 20.1% habenular calcification, 7.3% tentorium cerebelli, sagittal sinus or falx cerebri calcifications, 6.6% vascular calcification, 0.8% basal ganglia calcification and 0.9% lens and other non-defined calcifications[1].

In our study, the most common incidence and sites of intracranial physiological calcification areas are 78%%, the pineal gland scored high degree of calcification followed by choroid plexus by 75 % , Habenula had 18 % of calcification, Tentorium & falx had 8 % and age related basal ganglia calcification 3%.

In the study of Kwak et al[2] in Japan the incidence of pineal gland and choroid plexus calcification was lower than in our research, but irrespective of this pineal gland calcification was the most common intracranial physiological calcification in this study too.

According to our study, Choroid plexus calcification was in the second place with much higher incidence of 75 % with right ventricle being the most common site. Weins J and Stenbeg A[3] obtained an incidence of 66.2 % calcification in the choroid plexus with less when compared to our study.

Habenula has a central role in the regulation of the limbic system and is often calcified with a curvilinear pattern a few millimeters anterior to the pineal body in 15% of the adult population. In our study habenula shows an incidence of 18 % which is on the higher aspect as compare other studies.

Kendall and Cavangh[4] report the same increase in calcifications in old age with an incidence of Tentorium cerebelli, sagittal sinus and falx cerebri (7.3 %) calcifications were most common in old age too, and pineal, habenular, and choroid plexus calcifications also increase at older age. In our study, intracranial physiological calcification also increases with age with an overall incidence of 8 % in Tentorium cerebelli, sagittal sinus and falx cerebri which is slightly higher than Kendall and Cavangh study.

Congenital calcification is frequently seen in Struge-Weber syndrome (SWS), tuberous sclerosis (TS) and intracranial lipoma, but rarely in neurofibromatosis (NF), cockayne (CS) and Gorlin syndromes (GS) .In our study did we find 2% of incidence in congenital calcification including one case of tuberous sclerosis (TS) and once case of Cockayne (CS).

According to Kiroglu et al, Calcification of the intracranial arteries associated with primary atherosclerosis is more frequent in elderly people. Other causes of vascular calcifications include aneurysm, arteriovenous malformation (AVM) and cavernous malformation. In our study we found AVM and Aneurysm in 2% of cases each.

Intracranial calcifications are common in patients with congenital infections, but their appearance is not specific because they reflect dystrophic calcifications similar to any chronic brain injury. In our study toxoplasmosis was found in 2% of patients.

Tuberculosis results in calcified parenchymal granulomata in 10% to 20% of patients;meningeal calcifications are much less common. HIV encephalitis is associated with basal ganglia calcification[5]. Cryptococcus affects immunocompromised patients and calcifications can be seen in both the brain parenchyma[6] and the leptomeninges.in our study 48 % of patients showed intracranial calcification out of with 46 % showed granulomas. Tuberculomas occupied the most with and incidence of 86.96 % showing nodular calcification in all of them.NCC showed an incidence of 13.04 % showing nodular calcification

According to Kiroglu et al, The most common intracranial neoplasms associated with calcifications are oligodendroglioma (70-90%), craniopharyngioma (50-80%), germ cell neoplasms (dysgerminoma,seminoma, tertoma, choriocarcinoma; (60- 80%), pineal neoplasms (pineoblastoma, pineocytoma, central neurocytoma(50-70%), primitive neuroectodermal tumor (PNET) (50-70%), ependymoma (50%), ganglioglioma (35-50%), dysembryonic neuroectodermal tumor (DNET) (20-36%), meningioma (20-25%), choroid plexus papilloma(25%), medulloplastoma (20%), low grade astrocytoma (20%), and pilocytic astrocytoma (10%). Calcifications are rarely seen in schwannomas, and dermoid and epidermoid tumors. In our study choroid plexus papilloma (33.33%), meningioma (18.6%), ependymoma (16.66 %), glioblastoma multiforme (16.66 %), oligodendroglioma (16.66%), pilocytic astrocytoma(16.66 %).

Intracranial calcifications can also be seen in rare idiopathic disorders such as Fahr disease (bilateral striopallidodentate calcinosis, This disease shows characteristic calcifications in the basal ganglia, especially in the lateral globus pallidus. Other involved areas are the thalami, the cerebral white matter and the dentate nuclei of the cerebellum[7]. Progressive and symmetric basal ganglia calcifications are the commonest radiological finding of MELAS syndrome[8].in our study bilateral basal ganglia calcification did find in 4 cases with an overall incidence of 4 %.

CONCLUSION

Computed tomography (CT) is the most sensitive means of detection of intracranial calcifications. With the use of CT, even minor degrees of calcification can be detected.

Simple radiography, computed tomography (CT), magnetic resonance imaging (MRI) and, for infants, ultra-sonography all help physicians in the diagnosis of intracranial calcifications, but CT has a high sensitivity.

Intracranial calcification is visualized 9 to 15 times more frequently with computed tomography (CT) than with plain skull radiography.

Knowledge of physiologic calcifications in the brain parenchyma is essential to avoid misinterpretations. Several pathologic conditions involving the brain are associated with calcifications and the recognition of their appearance and distribution helps narrow the differential diagnosis.

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