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Age and gender related prevalence of intracranial calcifications in CT imaging; data from 12,000 healthy subjects

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ABSTRACT

Purpose: Location and extent of intracranial calcifications have been detected accurately with the use of CT technology and since, many clinical or pathological entities have been linked to these calcifications. Our purpose is to provide data regarding the prevalence of calcifications in various locations in brain.
Material and methods: We retrospectively examined 11,941 subjects who underwent non-contrast enhanced brain CT examination. We determined the prevalence of choroid plexus, pineal gland, habenula, dura mater, basal ganglia and vascular calcifications.
Results: Of 11,941 subjects, 70.2% had choroid plexus calcifications. Calcifications were most frequently seen in pineal gland and 71.6% of the study population had pineal calcifications. Habeluna and dural calcifications were present in 19.2% and 12.5% of the population respectively. Basal ganglia calcifications and vascular calcifications only constituted 1.3% and 3.5% of the study population respectively. Male dominance was present in all calcification types except basal ganglia calcifications.
Conclusions: Showing associations and dissociations from the literature, our study provides a baseline data regarding the prevalence of various types of intracranial calcifications.

1. Introduction

Before the use of CT technology, assessing intracranial calcifications via roentgenograms was useful for detecting lesions which contains calcium (Camp, 1950). Detection of displaced intracranial physiologic calcifications on plain radiographs was one step forward as they could indicate the presence of intracranial mass effect (Young, 1949). Brain CT examinations made possible to detect, locate and classify these calcifications much more accurately (Gołabek et al., 1980). Later on, studies focused on association between various diseases and intracranial calcification types such as vascular calcifications in stroke patients (Sohn et al., 2004) and basal ganglia calcifications in patients with hypoparathyroidism (Sachs et al., 1982). Recent studies with advent CT technology, have coupled the so called physiological calcifications in choroid plexus, pineal gland, habenula and dura mater with specific pathological entities (Ceylan et al., 2015; Kitkhuandee et al., 2014b; Ritchie and Davison, 1974; Sandyk, 1992).

Previous studies also have assessed the prevalence of intracranial calcifications in adults. Few of these had a study population that consisted of more than a thousand subjects (Daghighi et al., 2007; Kwak et al., 1988a; Kwak et al., 1988b). Our study has the largest sample size compared to those in literature. In addition we evaluated vascular calcifications as well as so called physiologic calcifications in same study population. In this study we aim to provide baseline data regarding the presence of intracranial calcifications without stratifying the population according to any disease or abnormality. Furthermore, we also aim to provide prevalence of relatively rare entities such as Fahr's syndrome, calcified meningioma and extensive dural calcifications.

Abbreviations: CPC, choroid plexus calcification; PC, pineal calcification; HC, habenula calcification; DC, dural calcification; BGC, basal ganglia calcification; VC, vascular calcification; ROI, region of interest; HU, hounsefield unit.

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2. Material and methods

2.1. Patient selection

All non-contrast enhanced brain CT examinations performed in our center that belong to subjects with no recorded diagnosis of any disease between 2009 and 2014 were listed in PACS database. From these data, 12,345 examinations were extracted without the repeated exams from same patients. During the reading sessions 404 examinations were excluded from reading due to technical issues and patient based problems (Fig. 1). Study data consisted of remaining 11,941 examinations. Study population was dominantly consisted of participants with Caucasian and Asian ethnicity.

2.2. Imaging procedure

All CT examinations were performed with 4-row (Asteion, Toshiba Medical, Tokyo, Japan) and 64-row (Aquillon, Toshiba Medical, Tokyo, Japan) multi detector computed tomography scanners. Imaging parameters were 120 kVp, 250 mAs, FOV of 25 cm, reconstruction matrix of 512 × 512, slice thickness of 5 mm. Images were transferred to workstation (Vitrea 2, Vital Images, MN, USA) and evaluated using brain window settings with a window width of 90 Hounsfield Units (HU) and a window level of 45 HU. Readings were performed by single radiologist (AY). For evaluation of inter-rater agreement, a subset of 3500 anatomic locations in 500 patients were re-read by second radiologist (IY). Hyperdensities within choroid plexus, pineal gland, habenula, basal ganglia, dural surfaces and cerebral vessels which were similar to bony structures by visual assessment were accepted as calcifications. When the calcifications could not be determined with visual assessment, circular ROI (region of interest) was used to calculate the density of the hyperdense area which recorded as calcification when the maximum calculated HU value of the ROI exceeded 100 HU. Bone window settings (window width; 2000-2600 HU; window level, 30-60 HU) were used to search the calcifications of paraclinoid internal carotid artery as well as other areas adjacent to bony structure. Pineal region was determined according to known anatomic landmarks such as mammillary body and third ventricle. Discrete calcification apart from pineal gland above this level was accepted as habenular calcification. Calcified menengiomas were determined if presence of non-calcified hyperdense tumoral tissue was detected. For complete calcified menengiomas, follow up imaging modalities and patient records were investigated. Non-discrete calcification seen along the dural surface with a thickness more than 5 mm accepted as extensive dural calcification.

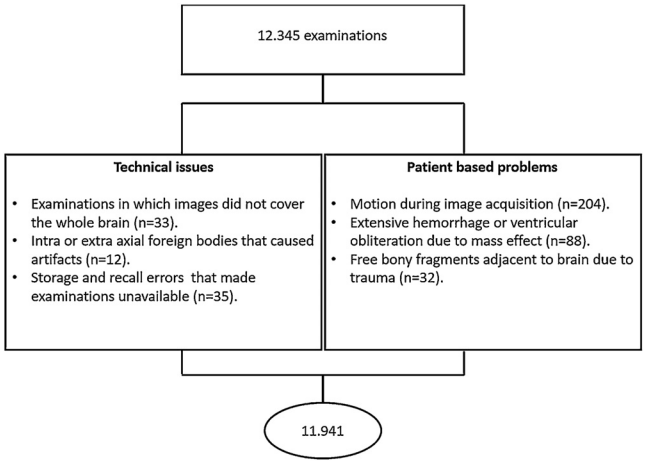

Fig. 1. Number of examinations which met exclusion criteria.

2.3. Statistical analysis

Data regarding the age are presented as mean ± standard deviation. Nominal categorical variables were assessed with the Fisher Exact test. Agreement between different readers was assessed by Kappa statistics. A two tailed p value <0.05 was considered statistically significant. Statistical analyses were performed using MedCalc statistics software (MedCalc, version 12.2.1.0, Mariakerke, Belgium).

3. Results

Study population consisted of 11,941 subjects and 48.3% of them were male. Mean age was 46.3 ± 17.7 (range: 15–85) for all subjects, 45.3 ± 17.9 (range: 15–85) for males and 47.3 ± 17.4 (range: 15–85) for females. In study population, 1290 subjects with a mean age of 36.2 years had any calcification at all.

Two readers were agreed on 3254 of 3500 assessments (0.93) (k = 0.85, 95%CI: 0.826–0.865).

3.1. Choroid plexus calcifications

Of 11,941 subjects, 70.2% had choroid plexus calcifications (CPCs) (Table 1). CPCs were the second most common physiologic calcification type at the age between 15 and 45 years whereas it was the most common after fifth decade (Fig. 2).CPCs were seen significantly more frequent in males (Table 2). Pineal calcifications (PC) was the most common accompanied type of calcification in subjects with CPC (77.4%).

3.2. Pineal calcifications

Similar to CPC, 71.6% of the study population had pineal calcifications. Overall, PC was the most common physiologic calcification type. PCs were also seen significantly more frequent in males. Male dominance was more prominent in PC group than CPC group (Table 2). Co-occurrence of CPC and PC was very common as 54.4% of the study population had both pineal and choroid plexus calcifications.

3.3. Habenular calcifications

Habenular calcifications (HCs) were present in 19.2% of the study population. Mean age of the participants with HC was somewhat similar to CPC and PC (Table 1). HCs had male dominance as well as CPCs and PC (Table 2). Prevalence of PC in subjects with HC was as high as 93.9%.

Table 1
Incidence of different calcification types and mean age of the corresponding group.

	Number of Cases	Age (Mean, SD)
Choroid Plexus	8394 (70.2%)	49.8, 16.8
Pineal Gland	8559 (71.6%)	47.3, 17.4
Habenula	2301 (19.2%)	48.8, 17.0
Dura Mater	1495 (12.5%)	53.1, 17.8
Basal Ganglia	161 (1.3%)	52.4, 17.6
Vascular	424 (3.5%)	68.2, 10.2
Anterior	66 (0.5%)	69.0, 10.4
Posterior	130 (1%)	67.7, 9.7
Both	228 (2%)	68.2, 10.5