ÖZGÜN ARAŞTIRMA ORIGINAL RESEARCH

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COMPUTED TOMOGRAPHY FINDINGS OF INTRACRANIAL CALCIFICATIONS

İNTRAKRANİYAL KALSİFİKASYONLARIN BİLGİSAYARLI TOMOGRAFİ BULGULARI

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Öz

Amaç
Bu çalışmada beyin bilgisayarlı tomografi (BT) tetkiklerinde saptanan intrakraniyal kalsifikasyonların anatomik lokalizasyonu ve dağılımları belirlenip yaş ve cinsiyet ile ilişkisi araştırıldı.

Gereç ve Yöntem
Mart 2010-Mayıs 2013 tarihleri arasında çeşitli nedenlerle beyin BT tetkikleri yapılan 887 hastanın görüntüleri incelendi. Kontrastlı tetkik, kanama, travma, hidrosefali ve görüntü distorsiyonu nedeniyle 124 hastanın görüntüleri çalışma dışı bırakıldı. Kontrastsız beyin BT görüntüleri incelenen 763 hasta dekatlara göre yaş gruplarına ayrıldı. Hastalardaki pineal gland, koroid pleksus, habenula, bazal gangliyon, tentoryum serebelli, falks serebri, dura ve araknoid granülasyon, petroklinoid ligaman, arteriyel duvar, orbita kalsifikasyonları ile distrofik ve tümöral kalsifikasyonlar değerlendirildi. İntrakraniyal kalsifikasyonların yaş grupları ve cinsiyete göre dağılımları incelendi.

Bulgular
Çalışmaya dahil edilen hastaların 382'si (%50,1) kadın ve 381'i (%49,9) erkek idi. Hastaların 672'sinde (%88,1) intrakraniyal kalsifikasyon saptandı. En sık koroid pleksus (%78,2) kalsifikasyonları saptanırken, bunu sırasıyla habenula (%62,4), pineal gland (%55,3), arteriyel duvar (%31,2), petroklinoid ligaman (%28,7) ve falks serebri (%20,7) kalsifikasyonları takip etmekteydi. Daha az sıklıkta dura ve araknoid granülasyon (%7,5), bazal gangliyon (%6,3), tentoryum serebelli (%2,9) kalsifikasyonları, tümöral kalsifikasyon (%1,2) ile orbita (%0,5) kalsifikasyonları saptanırken, en az distrofik kalsifikasyonlar (%0,4) tespit edildi. Yaş gruplarına göre kalsifikasyonların dağılımında pineal gland, koroid pleksus, habenula, bazal gangliyon, tentoryum serebelli, falks serebri, dura ve araknoid granülasyon, petroklinoid ligaman ve arteriyel duvarda yerleşen kalsifikasyonlarda istatistiki olarak anlamlı farklılık saptandı. Cinsiyete göre dağılımda koroid pleksus, habenula, dura ve araknoid granülasyon ile petroklinoid ligaman kalsifikasyonlarında istatistiki olarak anlamlı farklılık saptandı.

Sonuç
İntrakraniyal kalsifikasyonlar en sık koroid pleksus, habenula ve pineal glandda saptanırken en az distrofik kalsifikasyonlar görülmektedir. İntrakraniyal kalsifikasyonların görülme sıklığı genellikle 10 yaşından itibaren artmaktadır. Kadınlarda tentoryum serebelli ile dura ve araknoid granülasyon kalsifikasyonları daha sık görülmektedir.

Anahtar Kelimeler: Bilgisayarlı tomografi, İntrakraniyal, Kalsifikasyon

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Abstract

Objective
In this study, the anatomical localization and distribution of intracranial calcifications detected on brain computed tomography (CT) were determined and their relationship with age and gender was investigated.

Material and Method
Images of 887 patients who underwent brain CT examinations for various reasons between March 2010 and May 2013 were analyzed. Images of 124 patients were excluded from the study because of contrast-enhanced examination, bleeding, trauma, hydrocephalus, and image distortion. Seven hundred sixty three patients whose non-contrasted brain CT images were analyzed were divided into age groups according to decades. The pineal gland, choroid plexus, habenula, basal ganglia, tentorium cerebelli, falx cerebri, dural and arachnoid granulation, petroclinoid ligament, arterial wall, orbital, dystrophic and tumoral calcifications were evaluated. The distribution of intracranial calcifications according to age groups and gender were examined.

Results
Of the patients included in the study, 382 (50.1%) were female and 381 (49.9%) were male. Intracranial calcification was detected in 672 (88.1%) of the patients. The choroid plexus (78.2%) calcifications were most common, followed by habenula (62.4%), pineal gland (55.3%), arterial wall (31.2%), petroclinoid ligament (28.7%), and falx cerebri (20.7%). Calcifications of dural and arachnoid granulation (7.5%), basal ganglia (6.3%), tentorium cerebelli (2.9%), tumoral (1.2%) and orbital (0.5%) were detected less frequently, while dystrophic calcifications (0.4%) were the least common. A statistically significant difference was found in the distribution of calcifications according to age groups, in calcifications located in the pineal gland, choroid plexus, habenula, basal ganglia, tentorium cerebelli, falx cerebri, dural and arachnoid granulation, petroclinoid ligament and arterial wall. A statistically significant difference was found in choroid plexus, habenula, dural and arachnoid granulation and petroclinoid ligament calcifications in distribution according to gender.

Conclusion
Intracranial calcifications are most frequently detected in the choroid plexus, habenula and pineal gland, while dystrophic calcifications are seen the least. The incidence of intracranial calcifications generally increases from the age of 10. Tentorium cerebelli and dural and arachnoid granulation calcifications are more common in female.

Keywords: Computed tomography, Intracranial, Calcification

Introduction

Intracranial calcification is defined as calcification in the cranial cavity, usually in the brain parenchyma or in the vascular system (1). The initial evaluation of patients with neurological findings is usually performed with non-contrasted brain computed tomography (CT) (2). Intracranial calcification is frequently detected incidentally on brain CT in these patients (3). Conventional radiographs can be used to detect intracranial calcifications; however, due to technological developments, CT has become an ideal imaging method due to its high sensitivity in the evaluation of bone tissue and calcifications, replacing the use of radiography (4). The pathogenesis of intracranial calcifications range from benign physiological processes to multiple pathological processes (3, 4). Being able to accurately recognize and distinguish physiological processes from pathological conditions significantly guides the patient's management and possible treatment needs (3). For these reasons, knowing the anatomical localization, distribution and morphology of intracranial calcifications are important markers that can help in the differential diagnosis (3, 4). In addition to radiological data, correlation with clinical and biochemical data helps the diagnosis more in these patients (3). Pineal gland and choroid plexus calcifications are the locations where intracranial calcifications are most common, followed by habenula, falx and basal ganglia, as well as vessel wall, cerebellum, and other regions (2, 5). In this study, anatomical localizations and distributions of intracranial calcifications detected on brain CT examinations were determined and their relations with age and gender were investigated.

Material and Method

Brain CT scans of 887 patients who underwent radiological imaging in Tokat Gaziosmanpaşa University Faculty of Medicine, Department of Radiology between March 2010 and May 2013 due

to headache, vertigo, cerebrovascular disease, epilepsy, syncope, and space-occupying lesions were included in this study. Patient images were randomly selected from the records in the image archiving and communication system (Sectra IDS7 PACS, Sweden). Images of 124 patients were excluded from the study because of contrast-enhanced examination, bleeding (parenchymal, intraventricular, epidural, subdural and subarachnoid hemorrhage), trauma, hydrocephalus, and image distortion. Patient images were evaluated with consensus by radiologists experienced in the field of radiology. Brain CT scans were performed on 2-slice (Siemens) or 8-slice (General Electric) CT devices. Brain CTs were obtained with a section thickness of 5 mm, and the images were evaluated both in the parenchyma and in the bone window. Seven hundred sixty three patients whose non-contrasted brain CT images were analyzed were divided into age groups according to decades. Calcifications in anatomical structures such as pineal gland, choroid plexus, habenula, basal ganglia, tentorium cerebelli, falx cerebri, dural and arachnoid granulation, petroclinoid ligament, arterial wall (in any cranial artery), orbit, and dystrophic and tumoral were detected in patients. Choroid plexus calcifications were evaluated according to whether they were located in the lateral ventricle, 4th ventricle, foramen Luscha and multiple ventricles. Basal ganglia calcifications were evaluated according to globus pallidus, putamen and lentiform nucleus locations. The distribution of intracranial calcifications by age groups and gender was analyzed statistically. The study was retrospective and local ethics committee approval was obtained (13-KAEK-171).

Statistical Analysis

Data are expressed as frequency and percent. Fisher's Exact test and Pearson Chi-Square test were used to compare the categorical data between/among groups. A p value <0.05 was considered significant. Analyses were performed using SPSS 20 (IBM SPSS Statistics 20, SPSS inc., an IBM Co., Somers, NY).

Results

The age range of 763 patients included in the study was 1-89 (mean 44.80±25.88), and 382 (50.1%) of the patients were female and 381 (49.9%) were male. Intracranial calcification was detected in 672 (88.1%) of the patients. The number of patients varied between 74 and 90 per decade, and the number of patients was close to each other. Of the patients with intracranial calcification, 338 (50.3%) were female and 334 (49.7%) were male. There was no statistically significant difference between age groups in terms of gender (p=0.999). Intracranial calcification was detected in all decades, and its incidence increased with age. Starting from the 5th decade, intracranial calcification was detected in at least one localization in all patients. Calcifications of the choroid plexus (78.2%) were most common, followed by habenula (62.4%), pineal gland (55.3%), arterial wall (31.2%), petroclinoid ligament (28.7%) and falx cerebri (20.7%), respectively. Dural and arachnoid granulation (7.5%), basal ganglia (6.3%), tentorium cerebelli (2.9%) calcifications, tumoral calcification (1.2%), orbital (0.5%) calcifications more less frequently, while dystrophic calcifications (0.4%) were detected the least common (Table 1). Distribution by age groups: pineal gland (p<0.001), choroid plexus (p<0.001), habenula (p<0.001), basal ganglia (p<0.001), tentorium cerebelli (p=0.025), falx cerebri (p<0.001), dural and arachnoid granulation (p=0.003), petroclinoid ligament (p<0.001) and arterial wall (p<0.001) calcifications were statistically significant (Table 2). In the distribution by gender,

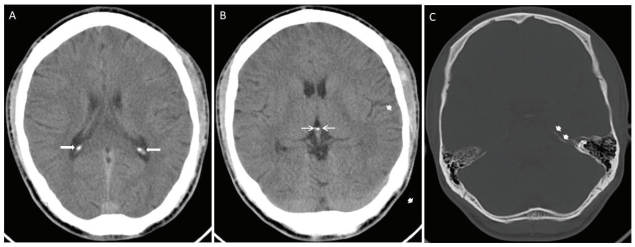

Figure 1
Axial non-contrasted brain computed tomography of a 20-year-old male patient; A) bilateral choroid plexus calcifications (thick arrows) in the lateral ventricles, B) habenula calcification (thin arrows) and C) left petroclinoid ligament calcification (arrowheads) are shown.

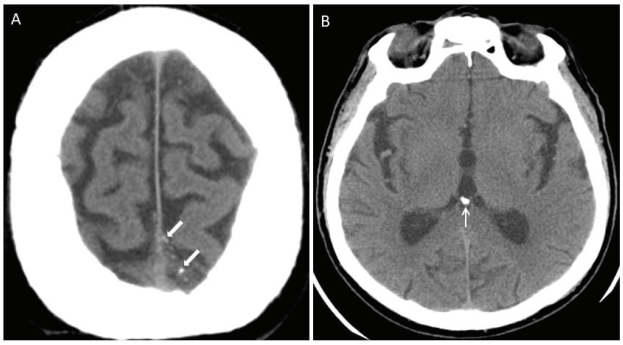

Figure 2
Axial non-contrasted brain computed tomography of an 81-year-old male patient; A) arachnoid granulation calcifications (thick arrows) and B) pineal gland calcification (thin arrow) are shown.

statistically significant differences were found in calcifications of the choroid plexus (p=0.019), habenula (p=0.022), dural and arachnoid granulation (p=0.040), and petroclinoid ligament (p=0.019) (Table 3). Calcifications in different localizations are shown in Figures 1, 2, 3 and 4.

Table 1 Distributions of quantitative variables

Variables	n	%
Age		
1-9	83	10.9
10-19	88	11.5
20-29	74	9.7
30-39	88	11.5
40-49	87	11.4
50-59	90	11.8
60-69	80	10.5
70-79	88	11.5
80-89	85	11.1
Gender		
Female	382	50.1
Male	381	49.9
Calcification (+)		
Pineal gland	422	55.3
Choroid plexus	597	78.2
Habenula	476	62.4
Basal ganglia	48	6.3
Tentorium cerebelli	22	2.9
Falx cerebri	158	20.7
Dural and arachnoid granulation	57	7.5
Petroclinoid ligament	219	28.7
Arterial wall	238	31.2
Orbital	4	0.5
Dystrophic	3	0.4
Tumoral	9	1.2

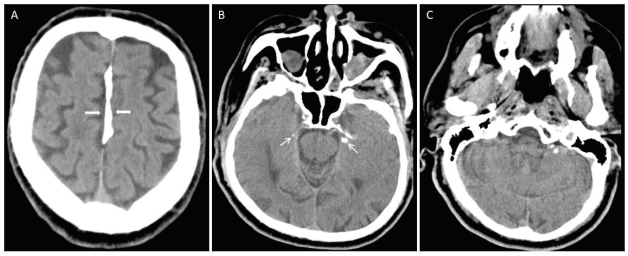

Figure 3
Axial non-contrasted brain computed tomography of a 74-year-old male patient; A) coarse calcification in falx cerebri (thick arrows), B) bilateral tentorium cerebel calcifications (thin arrows) and C) choroid plexus calcification (arrowhead) in left foramen Luscha are shown.

Table 2 Distributions of quantitative variables by age groups

Variables		Age									p value
		1-19	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Gender											
Female		42 (50.6)	43 (48.9)	37 (50)	45 (51.1)	42 (48.3)	44 (48.9)	43 (53.8)	45 (51.1)	41 (48.2)	0.999
Male		41 (49.4)	45 (51.1)	37 (50)	43 (48.9)	45 (51.7)	46 (51.1)	37 (46.3)	43 (48.9)	44 (51.8)	
Calcification (+)											
Pineal gland		3 (3.6)	28 (31.8)	42 (56.8)	55 (62.5)	48 (55.2)	63 (70)	59 (73.8)	56 (63.6)	68 (80)	**<0.001**
Choroid plexus	**a**	5 (6)	48 (54.5)	59 (79.7)	78 (88.6)	80 (92)	80 (88.9)	73 (91.3)	77 (87.5)	73 (85.9)	**<0.001***
	b	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.2)	
	c	0 (0)	0 (0)	0 (0)	0 (0)	1 (1.1)	0 (0)	0 (0)	0 (0)	0 (0)	
	d	0 (0)	0 (0)	0 (0)	1 (1.1)	1 (1.1)	4 (4.4)	3 (3.8)	5 (5.7)	8 (9.4)	
Habenula		4 (4.8)	42 (47.7)	44 (59.5)	67 (76.1)	64 (73.6)	68 (75.6)	62 (77.5)	60 (68.2)	65 (76.5)	**<0.001**
Basal ganglia	**e**	1 (1.2)	0 (0)	0 (0)	5 (5.7)	5 (5.7)	7 (7.8)	13 (16.3)	7 (8)	7 (8.2)	**<0.001***
	f	0 (0)	0 (0)	0 (0)	1 (1.1)	0 (0)	0 (0)	0 (0)	1 (1.1)	1 (1.2)	
Tentorium cerebelli		0 (0)	0 (0)	3 (4.1)	0 (0)	4 (4.6)	3 (3.3)	2 (2.5)	5 (5.7)	5 (5.9)	**0.025***
Falx cerebri		2 (2.4)	4 (4.5)	13 (17.6)	17 (19.3)	15 (17.2)	24 (26.7)	20 (25)	31 (35.2)	32 (37.6)	**<0.001**
Dural and arachnoid granulation		0 (0)	3 (3.4)	6 (8.1)	4 (4.5)	10 (11.5)	6 (6.7)	9 (11.3)	9 (10.2)	10 (11.8)	**0.003***
Petroclinoid ligament		0 (0)	6 (6.8)	14 (18.9)	33 (37.5)	19 (21.8)	30 (33.3)	35 (43.8)	44 (50)	38 (44.7)	**<0.001***
Arterial wall		0 (0)	0 (0)	0 (0)	0 (0)	1 (1.1)	0 (0)	0 (0)	1 (1.1)	2 (2.4)	**<0.001***
Orbital		0 (0)	0 (0)	0 (0)	0 (0)	1 (1.1)	0 (0)	0 (0)	1 (1.1)	2 (2.4)	0.356*
Dystrophic		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2.3)	1 (1.2)	0.206*
Tumoral		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2.2)	2 (2.5)	3 (3.4)	2 (2.4)	0.098*

n: number; %: percent, a: single lateral ventricle, b: lateral ventricle bilateral, c: foramen Luscha, d: multiple ventricles, e: globus pallidus, f: lentiform nucleus.
*: Fisher's Exact test was used. Pearson chi-square test used for the others.

Table 3 Distributions of quantitative variables by gender

Variables (calcifications)		Gender		p value
		Female	Male	
		n (%)	n (%)	
Pineal gland		205 (53.7)	217 (57)	0.361
Choroid plexus	**a**	286 (74.9)	287 (75.3)	**0.019***
	b	0 (0)	1 (0.3)	
	c	1 (0.3)	0 (0)	
	d	5 (1.3)	17 (4.5)	
Habenula		223 (58.4)	253 (66.4)	**0.022**
Basal ganglia	**e**	29 (7.6)	16 (4.2)	0.103*
	f	1 (0.3)	2 (0.5)	
Tentorium cerebelli		15 (3.9)	7 (1.8)	0.085
Falx cerebri		76 (19.9)	82 (21.5)	0.579
Dural and arachnoid granulation		36 (9.4)	21 (5.5)	**0.040**
Petroclinoid ligament		95 (24.9)	124 (32.5)	**0.019**
Arterial wall		115 (30.1)	123 (32.3)	0.516
Orbital		2 (0.5)	2 (0.5)	0.999*
Dystrophic		1 (0.3)	2 (0.5)	0.999*
Tumoral		3 (0.8)	6 (1.6)	0.505*

n: number; %: percent, a: single lateral ventricle, b: lateral ventricle bilateral, c: foramen Luscha, d: multiple ventricles, e: globus pallidus, f: lentiform nucleus.
*: Fisher's Exact test was used. Pearson chi-square test used for the others.

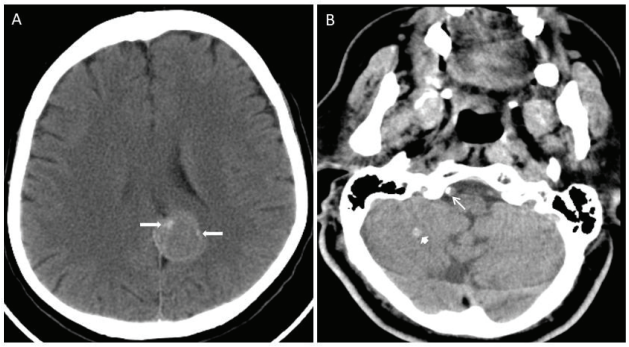

Figure 4
On axial non-contrasted brain computed tomography scans; A) A 59-year-old female patient with peripheral rim-shaped and calcified meningioma with focal hyperdense foci (thick arrows) B) A 74-year-old male patient with cavernoma (arrowhead) with focal hyperdense calcifications on the right of the cerebellum and atherosclerotic vessel wall calcification in the intradural segment of the right vertebral artery (thin arrow) is shown.

Discussion

Intracranial calcifications have been reported as a rare finding on conventional radiographs (6). However, CT is an imaging method that is 5-15 times more sensitive than flat head radiography in detecting intracranial calcification (7). In the first years of the application of CT, intracranial calcifications were detected between 0.3-1.2% on routine CT examinations, while this rate approaches 90% in current literature (8). In our study, the frequency of intracranial calcification (88.1%) was found to be similar to the literature. Improvement in CT technology (development of multidetector devices capable of helical scanning etc) and thin-

section scans may be responsible for the increase in the incidence of intracranial calcification. In the daily routine of radiologists, intracranial calcifications may be physiological as a common imaging finding in normal individuals, or may be pathological in individuals with other underlying diseases (9, 10). According to the etiopathogenesis of intracranial pathological calcifications; can be divided into 5 groups as vascular, tumoral, metabolic and endocrine, congenital and infectious (3, 11).

Physiological calcification occurs as a result of normal aging. These are not accompanied by any disease and there is no pathological cause (1, 5). The most common sites of intracranial physiological calcifications are the pineal gland, choroid plexus, habenula, falx cerebri, tentorium cerebelli, petroclinoid ligaments, basal ganglia, and vessel walls (5, 10, 11). Choroid plexus calcifications can be seen in all ventricles, most commonly in the lateral ventricle atria, near the foramen of Monro, and in the roof of the 4th ventricle (3). Although physiological and age-related calcifications can be seen frequently in adults and elderly patients, they are common physiological calcifications in the pineal gland in individuals ≥10 years old and in the globus pallidus in individuals ≥40 years old (10). Pineal gland calcification occurs in two-thirds of the adult population and its incidence increases with age. Detection of pineal calcification in the pineal gland in individuals larger than 14 mm or younger than 9 years old suggests neoplasm (3, 11).

In some studies in the literature on intracranial calcifications, pineal gland, choroid plexus, and habenula calcification were found in the range of 67.7%-71.6%, 66.2%-70.2%, 19.2%-20.1%, respectively (12-14). While pineal gland calcification is the most common calcification in the literature, the fact that choroid plexus (78.2%) and habenula (62.4%) calcifications were detected more frequently in our study is the difference between our study and the literature. This situation can be explained by the population differences examined in the studies. In the literature, calcification was found in one patient under the age of 10 in the lateral ventricular choroid plexus, while habenula calcification was not reported under the age of 10 (15). In our study, pineal gland calcification was detected in 3 cases under the age of ten, calcification in 5 cases in the unilateral lateral ventricular choroid plexus and in 4 cases in the habenula, and no pathological condition could be detected to explain the calcifications in these patients. In our study, a significant increase was found in the frequency of calcifications in these three locations from the age of 10.

Intracranial calcifications due to primary atherosclerosis increase with age and are common in individuals older than 65 years (4, 11). These calcifications are located in the walls of the clinoid segment of the internal carotid arteries (60%), vertebral arteries (20%), middle cerebral arteries (5%) and basilar arteries (5%), and are found as linear or punctate calcifications (3, 4, 11) . In a study conducted with a large series, calcification in the arterial wall was detected in 3.5% of individuals, and calcification in the arterial wall was detected very rarely before the age of 41 in these individuals (12). In our study, arterial wall (31.2%) calcifications were found to be higher, and calcifications were detected in only 12 cases before the age of 50. In our study, there was an increase in the frequency of calcification in the arterial wall after the age of 50.

The dura mater, which is the meningeal outer layer consisting of thick connective tissue surrounding the brain, and the falx cerebri and petroclinoid ligaments, which are thick like the dura mater, tend to calcify (4, 5). Falx cerebri calcifications appear as dense flat plaques located in the midline between the cerebral hemispheres. Other dural calcifications are typically laminar and not limited to a particular cortical region (16). Calcifications of the dura mater, falx cerebri or tentorium cerebelli are seen in approximately 10% of the elderly population (11). These calcifications may be detected incidentally or may occur with a number of pathological conditions, including basal cell nevus syndrome and pseudoxanthoma elasticum (3). In our study, calcifications of the petroclinoid ligament (28.7%) and falx cerebri (20.7%) were found at a higher rate than in the literature. However, dural and arachnoid granulation (7.5%) and tentorium cerebelli (2.9%) calcifications were found at a lower rate compared to the literature. In our study, tentorium cerebelli calcification was detected starting from the age of 20, while calcifications of the petroclinoid ligament, dural and arachnoid granulation started to be seen from the age of 10. Physiological calcification of the falx cerebri was detected at a rate of 2% in the literature (15), and in our study, falx cerebri calcification was detected incidentally in 2 cases before the age of 10 years (2.4%).

The incidence of calcification in the basal ganglia is 0.3-1.5%, and it usually has idiopathic etiology (4). Congenital, endocrine, metabolic and toxic causes, infections, hypoxia and iatrogenic causes may take place in the etiology, and some of the basal ganglia calcifications are physiological (8). Basal ganglia calcifications are mostly seen bilaterally and symmetrically, and the frequency of calcifications in bilateral basal ganglia increases with age, but most of

them do not show any symptoms (7, 8, 11). Thin, pale and dotted, coarse and trabeculated, conglomerating calcifications can be seen in the basal ganglia (3, 4). Rates between 0.28% and 12.5% have been reported in the literature for calcifications detected in the basal ganglia (6, 13, 14, 17, 18). In our study, the frequency of calcification in the basal ganglia (6.3%) was within the range reported in the literature. Thanks to the increase in the frequency of CT examinations and the developments in CT technology, there is an increase in the detection rates of intracranial calcifications, especially basal ganglia calcifications. In the literature, the majority of basal ganglia calcifications have been reported in the globus pallidus (98.4%) (12). In our study, the majority of basal ganglia calcifications were detected in the globus pallidus (93.8%), and it was found to be very close to the literature. If calcification in the basal ganglia occurs in patients younger than 40 years of age, pathologies of metabolic or endocrine origin should be investigated (3). The most common metabolic cause is pseudohypoparathyroidism, followed closely by hypoparathyroidism (16). In our study, idiopathic calcification was found in the basal ganglia in 7 patients younger than 40 years of age. In the largest series in the literature, basal ganglia calcifications were found more frequently in women, while other types of calcification (choroid plexus, pineal gland, habenula, dura mater, and arterial wall) were found to be higher in men (12). In our study, besides basal ganglia calcifications, tentorium cerebelli, dural and arachnoid granulation calcifications were found more frequently in women. In addition, statistically significant differences were found in the choroid plexus, habenula, dural and arachnoid granulation and petroclinoid ligament calcifications in our study according to gender.

Orbital calcifications are detected incidentally in characteristic locations. Common orbital calcifications include trochlear calcifications, scleral plaques, optic drusen, and phthisis bulbi (19). In a study evaluating asymptomatic orbital calcifications, calcification was found in 8% of individuals (20). In another study, orbital calcification was reported with a rate of 0.87% in benign orbital lesions (21). In our study, orbital (0.5%) calcifications were detected from the age of 40 years and its frequency was found to be lower than the literature.

Generally, dystrophic calcifications can be seen in damaged brain tissue as a result of ischemic injury, infections, trauma, and iatrogenic causes. Dystrophic calcifications are characteristically bilateral and can be seen most commonly in the cerebral subcortical location at the gray-white matter junction, then in the basal ganglia and cerebellar dentate nuclei (22). In a study, dystrophic calcification was found in 9.6% of individuals on CT examination (23). In our study, the least detected dystrophic (0.4%) calcifications were detected starting from the age of 70, and the frequency was found to be lower than the literature. This can be explained by the fact that trauma and bleeding patients were not included in our study and the patient population that could lead to dystrophic calcification was examined in other studies.

Hemorrhage and necrosis are thought to be responsible for many calcifications in intracranial tumors. The most common tumors showing calcification are oligodendrogliomas, 90% of which are calcified, and calcification can be seen in many tumors (11, 24). However, metastases rarely calcify (24). Evaluation of tumoral calcifications together with the patient's age, tumor localization and calcification pattern may contribute to the radiological differential diagnosis of intracranial neoplasms (11). Intracranial calcification is not correlated with tumor grade, but calcification may be a marker of successful treatment (24). In a study, calcification was found in 6.7% of brain tumors (25). In our study, tumoral (1.2%) calcifications were detected starting from the age of 50, and its frequency was found to be lower than in the literature.

Determining the cause of intracranial calcifications can be difficult because, depending on the age of the patient, there may be other causes of calcifications classified as physiological. The anatomical location, distribution, dimensions and morphology of such calcifications, together with the clinical history and age group, are important findings that can facilitate the differential diagnosis (10).

There are some limitations of our study. First, the study is retrospective. The second is that the examinations cannot be performed on the same device. Third, because most patients did not have follow-up imaging, evaluation of pathological conditions could not be made.

In conclusion, intracranial calcifications are most frequently detected in the choroid plexus, habenula and pineal gland, while dystrophic calcifications are seen the least. The incidence of intracranial calcifications generally increases from the age of 10. In addition, basal ganglia, tentorium cerebelli, dural and arachnoid granulation calcifications are more common in female.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Ethical Approval
We adhered to the Declaration of Helsinki principles. Ethical approval was attained from the Local Clinical Research Ethics Committee (Date and decision number: 8.20.2013: 13-KAEK-171).

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Authors Contributions
MB: Data curation; Validation; Resources; Visualization; Writing-original draft.

SY: Data curation; Formal analysis; Investigation; Validation; Writing-review & editing.

MEÇ: Data curation; Formal analysis; Investigation; Validation; Writing-review & editing.

EG: Conceptualization; Formal analysis; Investigation; Resources; Visualization; Supervision; Writing-original draft.

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