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# Different types of trochlear apparatus calcification: Evaluation with multidetector computed tomography (MDCT)

## Troklear aparat kalsifikasyonunun farklı tipleri: Çok kesitli bilgisayarlı tomografi (ÇKBT) ile değerlendirme

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**Abstract**

**Aim:** Trochlear apparatus calcification (TAC) can be an incidental finding in multidetector computed tomography (MDCT) scans. TAC may be misdiagnosed as a foreign body especially in trauma patients. In this study we aim to determine the incidence and types of TAC with cranial and paranasal MDCT scans.

**Materials and Methods:** Consecutive 452 MDCT scans were evaluated retrospectively. Repeated exams and patients with orbital wall fracture history were excluded. CT scans were obtained by a 64-slice scanner with 0.5 mm slice thickness. Reformatted and three-dimension volume rendered images in bone window were used to assess the calcification presence and type.

**Results:** Four hundred forty-one MDCT exams included to study. TACs detected in 31 (7.5%) subjects. TAC was unilateral in 24 (77.4%) and bilateral in seven (22.6%) subjects. There was no significant correlation with aging (p=0.681) and between genders (p=0.808). “Dot-like” TAC was the most common type (n=12, 31.6%). The other types were “inverted-U” (n=11, 28.9%), “linear” (n=8, 21%), “comma” (n=6, 15.6%), respectively. Eight (21%) of TACs were attaching the orbital wall, mostly in “comma” type.

**Conclusion:** The TAC incidence in our study was compatible with literature. Four different types of TAC, including, “dot-like”, “inverted U”, “linear” and “comma” types detected. TACs were usually discrete from the orbital wall however they were occasionally attached. “Linear” type TAC and attachment to orbital wall described for the first time in this study. Knowledge of the TAC appearance may be helpful to differentiate TACs from foreign bodies.

**Keywords:** Calcification, computed tomography, trochlear apparatus, orbit.

***Öz***

*Troklear aparat kalsifikasyonu (TAK), çok kesitli bilgisayarlı tomografi (ÇKBT) incelemelerinde rastlantısal bir bulgu olabilir. TAK özellikle travma hastalarında yanlışlıkla yabancı cisim olarak değerlendirilebilir. Bu çalışmada amacımız kraniyal ve paranasal sinüslere yönelik ÇKBT incelemelerinde TAK sıklığını ve tiplerini belirlemektir.*

***Gereç ve Yöntem:** Ardışık 452 ÇKBT incelemesi retrospektif olarak değerlendirildi. Tekrar edilmiş incelemeler ve travma öyküsü bulunan hastaların görüntüleri değerlendirme dışı bırakıldı. BT incelemeleri 64-dedektörlü cihazla 0.5 mm kesit kalınlığında elde olundu. Reformat ve üç boyutlu hacim kazandırılmış görüntüler, kalsifikasyon varlığı ve tipinin belirlenmesi için kullanıldı.*

***Bulgular:** Çalışmaya 441 inceleme dahil edildi. 31 (%7.5) olguda TAK saptandı. TAK 24 (%77.4) olguda tek taraflı, 7 (%22.6) olguda iki taraflıydı. Yaşlanma (p=0.681) ve cinsiyet (p=0.808) ile anlamlı korelasyon saptanmadı . “Nokta-benzeri” en sık görülen TAK tipiydi (n=12, % 31.6). Diğer tipler sırasıyla “ters-U” (n=11, %28.9), “çizgisel” (n=8, %21), “virgül” (n=6, %15.6) şekildeydi. En fazla “virgül” şekilli olmak üzere, TAK’ların 8’i (%21) orbita duvarına yapışık görülmekteydi.*

***Sonuç:** Çalışmamızda bulunan TAK sıklığı literatür ile uyumluydu. “Nokta-benzeri”, “ters-U”, “çizgisel” ve “virgül” şeklinde olmak üzere TAK’ın dört farklı tipi saptandı. TAK genellikle orbita duvarından ayrık izlenmesine rağmen ara sıra duvara yapışık olduğu görüldü. “Çizgisel” tip TAK ve orbita duvarına yapışık olması ilk defa bu çalışmada tanımlanmıştır. TAK farklı görünüm şekillerinin bilinmesi, TAK’larının yabancı cisimden ayrılmasında yararlı olabilir.*

***Anahtar Sözcükler:** Kalsifikasyon, bilgisayarlı tomografi, troklear aparat, orbita.*

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## Introduction

Orbital calcifications may be located in intra or extraocular compartments and occur in various conditions (1-3). Trochlear apparatus calcification (TAC) is an extraocular calcification located at the superior nasal part of the orbit and may be detected incidentally with non-contrast multidetector computed tomography (MDCT) (4).

The TAC may be misdiagnosed as a foreign body, especially in patients with trauma history. Knowledge of TAC location and type may prevent the misdiagnosis (5). In this study we evaluated the incidence and types of TAC with MDCT scans.

## Materials and Methods

An institutional approval obtained from the local ethic committee before the study. Consecutive 452 non-contrast cranial and paranasal sinus CT scans in which orbits were included to scanning area, performed between August 2013 and April 2015 were evaluated respectively. The CT scans were performed for detecting intracranial and sinonasal pathologies. Repeated exams and subjects with orbital wall fracture history were excluded. CT scans were performed at 64-slice scanner (Toshiba Aquillon 64, Otawara, Japan). Continuous non-overlapping sections of CT scan were obtained with acquisition parameters of 0.5 mm slice thickness, 120 kV, and 200mAs. The pixel spacing was 0.3 mm x 0.3 mm. The slice thickness was 0.5 mm. After image acquisition, the raw data was processed and transferred in DICOM (The Digital Imaging and Communications in Medicine standard) format to the workstation (Aquarius Intuition edition ver. 4.4.6, TeraRecon, Foster City, Calif). Three-dimensional volume-rendering and axial, coronal and sagittal reformatted images were evaluated for calcification presence and determining calcification type at the trochlear apparatus. A single radiologist with a 10-years' experience performed the evaluation.

The age and gender of subject; TAC existence, side and type were recorded. TAC types were grouped according to the classification described in a previous study (5). The prevalence, age distribution and gender predominance of TAC were analyzed. Additionally age-related distributions were also calculated.

Pearson chi-square and Spearman correlation tests were used for statistical analysis. A *p* value less than 0.05 was considered statistically significant.

## Results

Four hundred and forty-one CT scans of 452 subjects were included to study. The ages of the subjects were between 9 and 89 with a mean 45.7±18. Two hundred and twenty-nine (51.9 %) subjects were male. TAC was detected in 31 subjects. TAC incidence was 7.5% and was detected in 20 (8.7%) male and 11 (5.2%) female subjects, respectively. There was no statistically significant difference between gender with chi-square test (p=0.808).

The occurrence of TAC in different age groups is shown in Table-1. TACs were mostly detected in 5$^{th}$, 4$^{th}$ and 6$^{th}$ decades. However TAC had no correlation with aging (Spearman correlation test, p=0.681, r=-0.024).

**Table-1.** Age Distribution of Subjects with TAC*.

| Age group (years) | Age distribution | Age correction** |
|---|---|---|
| ≤20 | 2/441 (0.45%) | 2/48 (4.16%) |
| 21-30 | 4/441 (1.76%) | 4/62 (6.45%) |
| 31-40 | 7/441 (1.58%) | 7/72 (9.72%) |
| 41-50 | 8/441 (1.81%) | 8/90 (8.88%) |
| 51-60 | 6/441 (1.36%) | 6/80 (7.50%) |
| 61-70 | 2/441(0.45%) | 2/50 (4.00%) |
| 71≥ | 2/441 (0.45%) | 2/39 (5.12%) |

*Trochlear apparatus calcification
**Subjects with TAC in age group/ total number of subjects.

The TAC was unilateral in 24 (77.40 %) subjects and 7 (22.6 %) subjects had bilateral TACs. Totally 38 TACs detected. Twenty (52.6 %) of TACs were at the right side and 18 (47.4 %) of them were at left. There was no significant difference between two sides.

Twelve (31.6%) of TACs were "dot-like" calcifications (Figure-1). The others were "inverted U" (n=11, 28.9%), "linear" (n=8, 21.0%) and "comma" (n=6, 15.6%) types, respectively (Figure-2,3,4). Most of the TACs were not attached to orbital wall. However 8 (21.0%) of TACs were attaching (Figure-4). The most common type attaching to the orbital wall was "comma" type with 83%.

## Discussion

The incidence of TAC was 7.5% in our study. After TAC was described by Mafee et al. (6), several studies were published about this topic. The calcification incidence was reported at varying rates (Table-2). The lowest ratio of TAC was 3% in 100 CT scans which was reported by Murray et al. (1). Ko and Kim (3) reported the highest incidence of 16% in 216 patients. In our study, incidence of TAC is correlated with the literature.

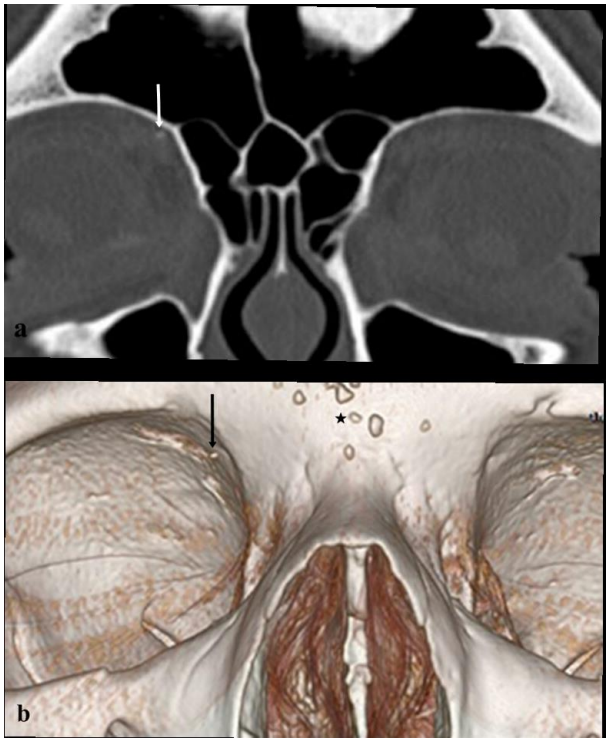


**Figure-1.** Coronal non-contrast CT image in bone window shows the "dot-like" TAC (white arrow) **(a)** at the right orbit. Same TAC (black arrow) is demonstrated with three-dimensional volume rendering (3D VR) image **(b).** Black star shows the subcutaneous calcifications at the frontal region.

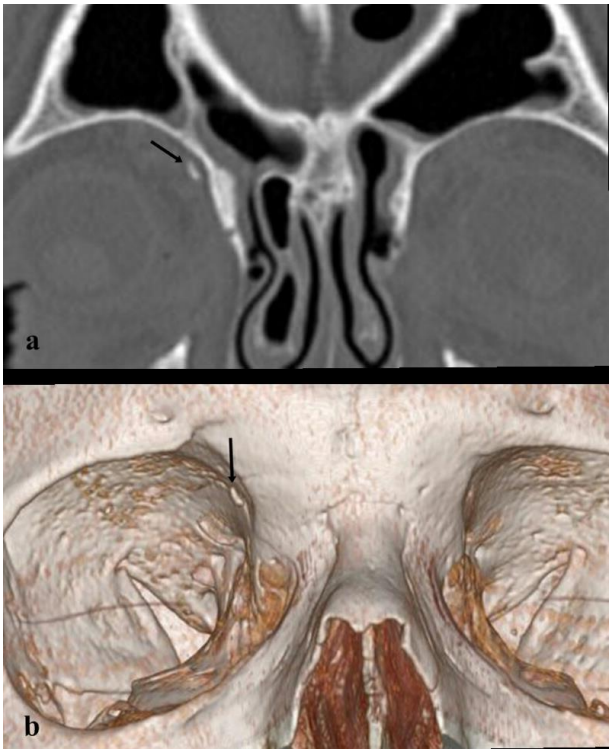


**Figure-3.** "Linear" type TAC at the right orbit (black arrow) is shown in coronal CT **(a)** and 3D VR **(b)** images. The calcification was discrete from the orbital wall.

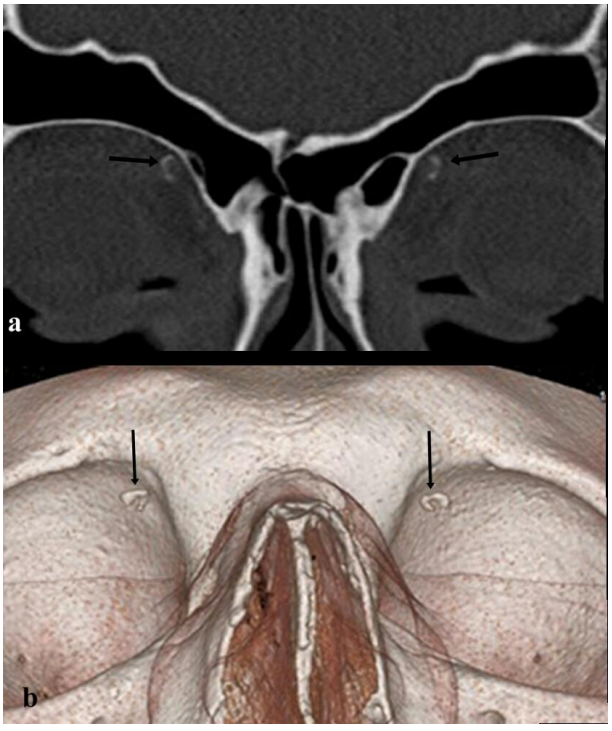


**Figure-2.** Black arrows demonstrate bilateral "inverted-U" type TACs in non-contrast coronal CT **(a)** and 3D VR **(b)** images.


**Figure-4.** Bilateral "comma" type TACs (black arrows) attaching to the orbital walls in coronal plane **(a)** and 3D VR **(b)** images.

**Table-2.** The TAC* Incidence in Our and Previous Studies.

| Study | Total subjects (n) | Subjects with TAC* (n) | % |
|---|---|---|---|
| Murray et al. (1) | 100 | 3 | 3 |
| Xiao et al. (5) | 403 | 27 | 6.7 |
| Hart et al. (8) | 159 | 19 | 12 |
| Ko and Kim (4) | 216 | 35 | 16 |
| Buch et al. (9) | 968 | 128 | 13 |
| Sobel and Goldstein (13) | 132 | 17 | 13 |
| Çolak et al. (10) | 176 | 25 | 14.2 |
| Bülbül et al. | 441 | 31 | 7.5 |

***Trochlear apparatus calcification.

The trochlea is a cartilaginous saddle attached to periorbita of the frontal bone in the superior nasal orbit. This cartilaginous saddle is separated from a fibrovascular sheath by a bursa-like space. The tendon of the superior oblique runs within this sheath (7). Although the exact location of calcification at the trochlear apparatus is not clear, cartilage, the synovial sheath, and the tendon are possible sites. The TAC etiology is not certain, however metabolic, inflammatory and degenerative diseases considered to be potential causative factors (8). TAC thought to be a marker for diabetes mellitus (DM) for patients younger than 40 years old (8,10). However in a recently study performed by Buch et al. (9) did not find an association between TAC and DM. The authors declared that they had not enough data to reveal the relationship among them. Buch et al. (9) also reported a significant correlation with autoimmune diseases, elevated serum alkaline phosphate levels and TAC.

The shape of TAC was not reported in earlier mentioned reports because CT technology was not good enough to obtain thin slices. With the advances in CT technology, it is possible to acquire thin slices less than 1mm and multiplanar reformatted images. Xiao et al. (5) reported the first study evaluating the TAC morphology with MDCT. They assessed the orbital CT scans obtained in 3mm slice-thickness. The authors described three types of trochlear calcification as “comma, dot and inverted U” types. Most of the TAC in their study was “comma” type (66.7%), followed by “dot” (22.2%) and “inverted U” (11.1%) types, respectively. We realized an additional type of TAC which had a “linear” shape. The most common type was “dot-like” similar to Xiao et al. study (5). However the ratio was lower and the second type “inverted U” had close ratio in our study. The shape of TAC may be related to the exact localization at the trochlear apparatus. Classification of TAC according to morphologic appearance can be helpful in differentiating from intraorbital foreign body especially in trauma patients (5).

An interesting finding in our study is the attachment of TAC to the orbital wall although TAC was previously described as a discrete calcification (8). We realized that in 8 (21.05%) subjects TAC was attaching with the orbital wall. As our best knowledge our report is the first one describing this finding. Slice thickness can be less than 1 mm and reformatted images are available in different planes with MDCT. Finding may not be detected previous reports because most of them were performed with thicker slices than our study. Most of TAC attaching to orbital wall was “comma” type. Attachment of TAC to orbital wall might be an additional finding in differentiating TAC from the foreign bodies.

Gender difference was investigated in previous reports. Xiao et al. (5) reported TAC in males two times more than females. The number of male subjects was approximately four times more than female subjects. This may explain the male dominance in their study. The other reports had lack of significant difference between genders like our study (3,8,9). The ratio of male and female subjects was nearly equal in our study and TAC was detected with same ratio in both genders. In an early study about TAC, an incidence increasement with aging reported (8). For this reason the authors suggested TAC could be a degenerative process. However there was no significant correlation found between TAC incidences and aging in the latter reports, including our study (1,3,9).

It is important to differentiate TAC from a metallic foreign body in patients whom require magnetic resonance imaging (MRI) (11). Metallic foreign bodies can move during MRI and may cause severe complications like blindness (12). Both TAC and metallic foreign body may have averaged attenuation in CT images.

This study has some limitations because of its retrospective nature. We couldn’t investigate the association of TAC with systemic pathologies because we didn’t have enough data. Our study was based on the imaging findings and we were not able to correlate the calcification types with histopathologic findings.

**Conclusion**

The incidence of TAC in our study was compatible with the literature. Different TAC types including “dot-like, inverted U, linear and comma” types were detected. Some of TACs were attaching the orbital wall, mostly in comma type. Linear type TAC and attachment to orbital wall described for the first time in this study. Knowing the appearance of TAC in MDCT imaging may be helpful for differentiating TAC from foreign bodies and avoid misdiagnosis.

**Conflict of interest**

The authors declare that they have no conflict of interest.

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