

## The Evaluation of Incidentally Detected Head and Neck Region Soft Tissue Calcifications and Ossifications on Computed Tomography Images

### Bilgisayarlı Tomografi Görüntülerinde Rastlantısal Olarak Belirlenen Baş ve Boyun Bölgesi Yumuşak Doku Kalsifikasyonlarının ve Ossifikasyonlarının Değerlendirilmesi

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#### ABSTRACT

**Aims:** Unorganized accumulation of calcium stored in soft tissues is termed as heterotopic calcification, organized accumulation of it is termed as heterotopic ossification. The aim of this study was to evaluate retrospectively all head and neck region soft tissue calcifications/ossifications that are detected incidentally on computed tomography (CT) images of Turkish patients and to analyze them according to age and gender.

**Methods:** CT images of 917 patients were retrospectively analyzed in terms of the presence of head and neck soft tissue calcification/ossification, and demographic characteristics (age and gender) of the patients were recorded. The data were analyzed with descriptive statistical methods and the relationship between soft tissue calcification/ossification and gender was evaluated with the chi-square test.

**Results:** Soft tissue calcification/ossification was detected on CT images of 214 (mean age= 61.35±14.7 years, 50.5% female, 49.5% male) of 917 patients examined (23.3%). Among the calcifications/ossifications detected, tonsillolith (n=120, 56.1%), arterial calcifications (n=61, 28.5%) and sialolith (n=15, 7%) were determined in the first three rows. Tonsillolith was significantly more common in female and ossified stylohyoid ligament (OSL) was significantly more common in male (p<0.05).

**Conclusions:** Soft tissue calcifications/ossifications can be detected incidentally in radiographic images taken from head and neck region for various purposes. In the study, tonsillolith was the most common soft tissue calcification on CT images. It was found that the tonsillolith was statistically higher in female, and the OSL in male. These calcifications/ossifications were most frequently found in patients over age 40.

**Keywords:** Multidetector computed tomography, physiologic calcification, pathologic calcification, heterotopic ossification

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## Ö Z E T

**Amaç:** Kalsiyumun yumuşak dokularda birikmesine heterotopik kalsifikasyon, organize birikimine heterotopik ossifikasyon denir. Bu çalışmanın amacı, Türk hastaların bilgisayarlı tomografi (BT) görüntülerinde rastlantısal olarak saptanan tüm baş ve boyun bölgesi yumuşak doku kalsifikasyonlarını/ossifikasyonlarını retrospektif olarak değerlendirmek yaş ve cinsiyete göre analiz etmektir.

**Yöntemler:** 917 hastanın BT görüntüleri baş boyun yumuşak doku kalsifikasyonu/ossifikasyonu açısından retrospektif olarak incelendi ve hastaların demografik özellikleri (yaş ve cinsiyet) kaydedildi. Veriler tanımlayıcı istatistiksel yöntemlerle analiz edildi ve yumuşak doku kalsifikasyonu/ossifikasyonu ile cinsiyet arasındaki ilişki ki-kare testi ile değerlendirildi.

**Bulgular:** İncelenen 917 hastanın (%23,3) 214'ünün (ortalama yaş= 61,35±14,7 yıl, %50,5 kadın, %49,5 erkek) BT görüntülerinde yumuşak doku kalsifikasyonu/ossifikasyonu tespit edildi. Tespit edilen kalsifikasyonlardan/ossifikasyonlardan ilk üç sırada tonsillolit (n=120, %56.1), arteriyel kalsifikasyonlar (n=61, %28.5) ve sialolit (n=15, %7) saptandı. Tonsilolit kadınlarda, ossifiye stilohyoid ligament (OSL) erkeklerde anlamlı olarak daha sıkı (p<0.05).

**Sonuç:** Baş ve boyun bölgesinden çeşitli amaçlarla alınan radyografik görüntülerde rastlantısal olarak yumuşak doku kalsifikasyonları/ossifikasyonları saptanabilmektedir. Çalışmada, BT görüntülerinde en sık görülen yumuşak doku kalsifikasyonu tonsillolit idi. Kadınlarda tonsillolit, erkeklerde OSL istatistiksel olarak daha yüksek bulundu. Bu kalsifikasyonlar/ossifikasyonlar en sık 40 yaş üstü hastalarda bulundu.

**Anahtar Kelimeler:** Çok kesitli bilgisayarlı tomografi, fizyolojik kalsifikasyon, patolojik kalsifikasyon, heterotopik ossifikasyon



## 1. Introduction

Physiological mineralization is limited to the certain regions in skeletal tissues like growth cartilage, bones and teeth. However, calcium salts can accumulate uncontrollably in any soft tissue [1]. Soft tissue calcifications/ossifications are divided into groups according to their formation mechanism, etiology and localization [2,3]. As unorganized accumulation of calcium salts stored in soft tissues is termed as heterotopic calcification, organized accumulation of it is termed as heterotopic ossification [2,4]. Heterotopic calcifications are divided into three different categories as dystrophic, idiopathic and metastatic calcifications. Dystrophic calcifications are a form of calcification that occur in degenerated, diseased or dead tissues in individuals with normal serum calcium and phosphate levels. Calcifications in this group are calcified lymph node, tonsillolith, cysticercosis and arterial calcifications. Idiopathic calcifications take place as a result of the accumulation of calcium in normal tissues despite the normal levels of serum calcium and phosphate. The examples of such calcifications are sialolith, phlebolith, laryngeal calcification and anthrolith-rhinolith-dacryolith [2,3]. Metastatic calcifications of the soft tissues are detected in conditions with high serum calcium and phosphate levels, such as hyperparathyroidism, hypercalcemia of malignancy, hypervitaminosis D and chronic kidney failure [4]. As for heterotopic ossification types, ossified stylohyoid ligament (OSL), osteoma cutis and myositis ossificans can be given as examples [2,5]. Soft tissue calcifications/ossifications in maxillofacial region are common and they are usually detected incidentally after routine radiographic images taken for diagnosis and treatment in dentistry [3,6]. When soft tissue calcifications/ossifications are detected, the primary object

should be to determine whether treatment is required. Knowing the frequency, gender and age distribution of soft tissue calcifications/ossification helps to determine the treatment status [2]. Conditions such as sialoliths that may cause pain, swelling and salivary gland dysfunction, OSL that may be associated with Eagle's syndrome, and atherosclerotic plaque that may be associated with cardiovascular disease risk are clinically important, may require intervention and follow-up [2,7].

Most of these calcifications are asymptomatic and diagnosed incidentally on panoramic radiography which is one of the two-dimensional imaging techniques frequently used in dentistry [8]. For detecting the soft tissue calcifications/ossifications, it may be beneficial to take a radiograph from different angles, examine with ultrasonography or use three-dimensional imaging techniques in addition to the patient's history and clinical examination [2,4]. Computed tomography [CT], which is one of the three-dimensional imaging technique, allows examining normal and pathological conditions in soft tissues in different planes as well as showing the changes in the bone.

It was aimed in this study to determine the incidence, age and gender distribution of soft tissue calcifications/ossifications in the head and neck region on CT images, to review the information on this subject in the light of current literature and to increase the awareness of clinicians.

## 2. Material and Method

In this study, head and neck CT images of 1323 patients who consulted Suleyman Demirel University with adenoid hyperplasia, acute pharyngitis, sialadenitis, thyroiditis, localized swelling in the neck, lymphadenitis, dysphagia reasons were analyzed retrospectively by two observer (a dentomaxillofacial radiology research student and specialist radiolog). CT images were obtained with a 128-slice multi-detector SOMATOM Definition AS Siemens CT device (Siemens Healthcare, Erlangen, Germany) and taken as the section thickness of the acquired images = 1 mm; matrix = 512x512; collimation = 128x0.6; section increment = 0.7; pitch = 0.8 and FOV = (25-30 cm). All pathologies and images with artifacts were excluded from the study, except for soft tissue calcifications/ossifications in the head and neck region. Besides, CT images of the patients who were requested due to the detected soft tissue calcifications/ossifications were excluded from the study. CT images of 917 patients (524 men, 393 women) with diagnostically optimum quality were included in the study and analyzed by examining axial, coronal and sagittal sections on the PACS system [Picture Archiving and Communication Systems]. The presence of soft tissue calcifications/ossifications, which could be detected in the head and neck region, and the demographic characteristics [age and gender] of the patients were evaluated. SPSS 22 software program [IBM SPSS Statistics 22] was used to evaluate the findings obtained from the study. Soft tissue calcifications/ossifications were classified and the data were analyzed by descriptive statistical methods. The frequency of soft tissue calcification/ossification and the relationship between genders were evaluated with the chi-square test. A value of  $p < 0.05$  was considered statistically significant.

## 3. Results

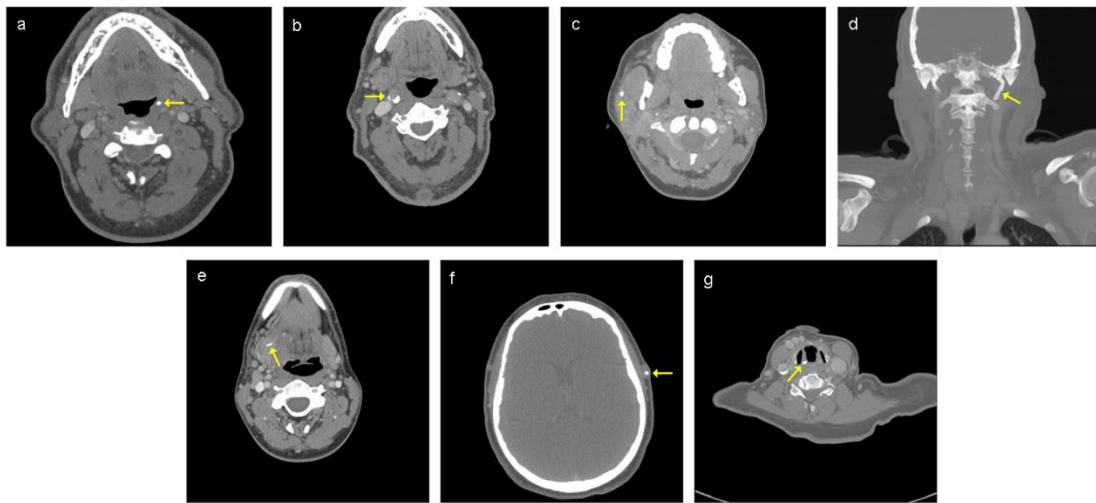
Soft tissue calcification/ossification was detected in 214 of 917 patients examined in our study (23.3%). Of the patients with soft tissue calcification/ossification, 50.5% were female ( $n=108$ ) and 49.5% were male ( $n=106$ ). These calcifications/ossifications were most frequently found in patients over age 40 years ( $n=193$ , 90.2%). Multiple calcifications/ossifications were detected in only seven patients. The gender distribution, mean age values and age ranges of the patients with soft tissue calcification/ossification are shown in Table 1.

**Table 1:** Gender distribution, mean age values and age range in soft tissue calcifications/ossifications

	Female	Male	Mean Age $\pm$ Standard deviation [SD]	Age range
<b>Tonsillolith</b>	69	51	58.9 $\pm$ 14	19-90
<b>Arterial Calcifications</b>	31	30	71.1 $\pm$ 11	40-93
<b>Sialolith</b>	6	9	47.7 $\pm$ 16	27-82
<b>Ossified Stylohyoid Ligament</b>	2	12	58.7 $\pm$ 16	26-90
<b>Calcified Lymph Node</b>	1	6	59.3 $\pm$ 13	45-82
<b>Osteoma cutis</b>	2	2	63.3 $\pm$ 8	53-72
<b>Arytenoid Cartilage Calcification</b>	1	0	71	71

More than one calcification/ossification were detected in only seven patients.

It has been observed that the most common type of calcification/ossification was tonsillolith, while the least common was arytenoid cartilage calcification. The distribution of identified soft tissue calcifications/ossifications is depicted respectively tonsillolith (n=120, 56.1%), arterial calcifications (n=61, 28.5%), sialolith (n=15, 7%), OSL (n=14, 6.5%), calcified lymph node (n=7, 3.3%), osteoma cutis (n=4, 1.9%), arytenoid cartilage calcification (n=1, 0.5%) (Figure 1).



**Figure 1:** Yellow arrows pointing to soft tissue calcifications/ossifications in axial and coronal sections of CT. **a** Tonsillolith located in left tonsilla closer to airspace in axial section, **b** Calcified atheroma plaque located in right carotid artery in axial section [arterial calcification], **c** Sialolith in the right parotid gland in axial section, **d** Ossified stylohyoid ligament extending from the temporal bone in coronal section, **e** Calcified lymph node in the submandibular lymph node in axial section, **f** Osteoma cutis in subcutaneous adipose tissue at left side of the head in axial section, **g** Arytenoid cartilage calcification in axial section.

It has been seen that tonsillolith and arterial calcifications were more common in female, while sialolith, OSL and calcified lymph node were more common in male (Table 2). There was a significant difference between genders considering tonsillolith and OSL ( $p < 0.05$ ). No statistically significant difference was found between genders considering sialolith, arterial calcifications and calcified lymph node ( $p > 0.05$ ).

**Table 2:** Distribution of soft tissue calcifications/ossifications by gender

Soft Tissue Calcifications/Ossifications	Female		Male		Total [n]		p
	n	%	n	%	n	%	
Tonsillolith	69	63.9	51	48.1	120	56.1	0.021
Other calcifications/ossifications	39	36.1	55	51.9	94	43.9	
Arterial Calcifications	31	28.7	30	28.3	61	28.5	0.948
Other calcifications/ossifications	77	71.3	76	71.7	153	71.5	
Sialolith	6	5.6	9	8.5	15	7.0	0.567
Other calcifications/ossifications	102	94.4	97	91.5	199	93.0	
Ossified Stylohyoid Ligament	2	1.9	12	11.3	14	6.5	0.012
Other calcifications/ossifications	106	98.1	94	88.7	200	93.5	
Calcified Lymph Node	1	0.9	6	5.7	7	3.3	0.064
Other calcifications/ossifications	107	99.1	100	94.3	207	96.7	
Osteoma Cutis	2	1.9	2	1.9	4	1.9	-
Other calcifications/ossifications	106	98.1	104	98.1	210	98.1	
Arytenoid Cartilage Calcification	1	0.9	0	0.0	1	0.5	-
Other calcifications/ossifications	107	99.1	106	100.0	213	99.5	

\*  $p < 0.05$

## 4. Discussion and Conclusion

Soft tissue calcifications/ossifications occur as a result of the organized or unorganized accumulation of calcium salts in different places rather than the skeleton. The calcification/ossification types frequently seen in the head and neck region are calcified lymph node, tonsillolith, arterial calcifications, sialolith and OSL. These may not cause any obvious signs or symptoms and are mostly detected incidentally during radiological examination. Panoramic radiography is one of the two-dimensional imaging methods that are routinely used in dentistry and provide information about soft tissue calcifications/ossifications in the head and neck region within the image layer [2]. Two-dimensional imaging methods have limitations such as superposition and distortion that negatively affect the examination. Therefore, three-dimensional imaging techniques such as CT or cone-beam computed tomography (CBCT) are utilized to eliminate these limitations [9,10]. In literature, certain soft tissue calcifications/ossifications were examined on panoramic radiography, CT or CBCT images [6,7,8,11,12,13]. To the best of our knowledge, any study retrospectively examining all types of soft tissue calcifications/ossifications on head and neck region on CT images of Turkish patients does not exist. So CT imaging method was preferred in our study, which helps to distinguish the soft tissues better due to its better contrast resolution and less image-noise properties, and helps the examination of normal and pathological conditions in different planes.

The prevalence of soft tissue calcification/ossification at different populations varies between 2.61-27.64% in studies performed on panoramic radiography images [6,12,14,15], and 15-62.6% in studies performed on CBCT images [7,13,16]. In a study examining soft tissue calcification/ossification in the head and neck region of Turkish patients, their incidence was reported to be 33.4% on CBCT images [8]. In our study, the incidence of soft tissue calcification/ossification in the head and neck region on CT images of Turkish patients was indicated to be 23.3%. The variation in the results given in literature was thought to be due to the difference in the population studied, number of patients, and the imaging procedures used.

Demographic characteristics differ in patients with soft tissue calcifications/ossifications according to the population. In literature, some studies indicate that soft tissue calcification/ossification is more common in female [12, 17], in some other studies is more common in male [18,19], while some other studies it is reported to no difference between the genders [8,16]. Soft tissue calcifications/ossifications are generally seen in patients over the age of 40, but they can also be seen in children [6,20]. In three recent studies examining patients in Turkey, the mean age of patients with soft tissue calcification/ossification was  $52.12 \pm 17.62$ ,  $44.17 \pm 16.04$ ,  $51.2 \pm 15.6$ , respectively [8,12,19]. In these studies, it was reported that the patients with soft tissue calcification/ossification were mostly 40 years and older. Considering the demographic characteristics of the patients in our study, there was no difference between the gender, but when their age was evaluated, the majority were over 40 years old, which is consistent with the literature.

In studies evaluating the frequency of soft tissue calcifications/ossifications, it was stated that tonsillolith [6,14], OSL [12] or arterial calcification [15] were most common on panoramic radiographs; tonsillolith [8,16] or arterial calcifications [17] are frequently seen on CBCT; on the other hand, it was stated that tonsillolith [11] was seen frequently on CT. In our study, which will examine on CT images, the most common soft tissue calcification/ossification type was tonsilloliths and it was found to be compatible with most studies in literature. In addition, it was thought that the most common type and ranking of soft tissue calcification in literature differed according to the characteristics of the population [race, mean age], except for the imaging procedures.

Palatine tonsils are lymphatic tissue collections located in the palatine fossa on both sides of the oropharynx, which is limited to the palatoglossal and palatopharyngeal arches [21]. With the recurrence of inflammation in the tonsils, the crypts of the tonsils enlarge and tonsillolith occurs [2]. Tonsilloliths can be recognized on the lateral radiograph of the pharynx and on the panoramic radiograph. However, it is not possible to distinguish tonsils from arteries, lymph nodes or salivary glands on two-dimensional radiographs. Tonsilloliths can be easily distinguished from the surrounding bone structures by three-dimensional imaging methods such as CT and/or CBCT [21]. Tonsilloliths are identified as multiple small radiopaque masses superposed to the anterior border of the oropharyngeal airway space on panoramic radiography, as dense and homogeneous oval shaped opacities resembling multiple clusters of "rice grains" adjacent to the lateral oropharyngeal airway space on CBCT or CT imaging [22]. They are usually asymptomatic and do not require treatment, but treatment may be considered in elderly patients with

immunosuppression due to the risk of aspiration pneumonia [23]. In studies evaluating the prevalence of tonsilloliths on CT images have reported that the prevalence ranged from 16% to 46.1% [11,21,24,25,26,27], while the prevalence of tonsilloliths on CBCT images ranged from 4.9% to 34.1% [15,23,28]. In some studies, it has been reported that tonsilloliths are seen more frequently in men [24,26,27] and in some studies it is more common in female [21,25,28], there is also a study that found no difference between the genders [19]. While in our study, the prevalence of tonsilloliths was found to be 13.3% [in 120 of 917 patients]. It was determined that there was a statistically significant relationship between tonsilloliths and gender, and it was seen at a higher rate in female. The difference in results between studies; may depend on soft tissue resolution characteristics of imaging procedures [CT or CBCT], slice thickness, number of study populations, hormonal changes.

In cases such as old age, genetic disorders, and some systemic diseases, calcification may occur in the vessels [3]. Arterial calcifications are an important risk factor in cardiovascular diseases [19]. Calcified atherosclerotic plaque is often observed in the spaces between the cervical third vertebrae or adjacent to the greater cornu of the hyoid bone on panoramic radiographs. On CBCT image, it is noticed in the form of rice grains or as linear calcifications in the region of the carotid artery. Atherosclerosis appears as opacities called “tubule body” or “train track” on panoramic radiographs along the outer wall of the vessel, more often in the facial artery and less frequently in the carotid artery, and this appearance is pathognomonic [2,3,15]. Atherosclerosis causes high mortality, so early diagnosis is critical. It has been associated with various diseases, such as diabetes, osteoporosis, coronary artery disease and chronic kidney failure, and often occurs in after 50 years of age. The appearance and localization of arterial calcifications are helpful in the differential diagnosis [28]. It has been reported that the prevalence of carotid artery calcification in patients admitted for dental treatment varies between 3-5% [17]. In a study performed on panoramic radiographs, it was reported that carotid artery calcification was the most common in 1615 patients and it was more common in women than men [15]. Taguchi et al. [29] reported that carotid artery calcification is more common in postmenopausal women due to the loss of the protective effect of hormones. In our study, arterial calcifications were seen in the second frequency. It was thought that this situation was affected by systemic diseases due to the high mean age of the patients.

Sialoliths are soft tissue calcification that are formed by precipitation of calcium and phosphate salts in the salivary gland or duct, and most of them occur in submandibular salivary glands. Imaging methods such as plain radiographs, CT, CBCT, ultrasonography, and sialography are used for imaging sialoliths [12,30]. In studies evaluating the prevalence of sialoliths on panoramic images have reported that the prevalence ranged from 0.01% to 1% [6,31], while the prevalence of sialoliths on CBCT images ranged from 0.2% to 1.7% [8,23,28]. In our study, the incidence of sialolith was found to be 1.63%. This situation was thought to be caused by the use of different imaging methods and the population difference.

The stylohyoid complex includes the styloid process, the stylohyoid ligament, and the cornu minus of the hyoid bone. The styloid process, which is located anteromedially of the stylomastoid foramen, is a thin, long and cylindrical bony prominence of the temporal bone. The structure, which is approximately 20-25 mm in length and resembles a dry tree branch that thins from top to bottom, is located between the internal and external carotid arteries and the internal jugular vein. The stylohyoid ligament is a connective tissue band that attaches to the cornu minus of the hyoid bone originating from the apex of the styloid process and plays a role in chewing and swallowing processes. The ossification of the stylohyoid ligament usually extends down from the skull base and occurs bilaterally. The ossifying ligament can usually be noticed as a hard, pointed structure on palpation on the tonsils [2,3,32,33]. Although it is mostly asymptomatic, it is called “Eagle Syndrome” when symptoms accompanying ossification of the ligament are observed [2]. Classic eagle syndrome causing compression in cranial nerves and carotid artery syndrome causing compression of carotid arteries are seen as symptoms associated with OSL [12]. In classical type Eagle syndrome, there are complaints such as foreign body sensation in the throat during speech and swallowing, turning head, and tinnitus as a result of compression of the cranial nerves accompanying the ligament. Recent history of trauma in the neck region supports the diagnosis. In carotid artery syndrome, syncope and hemiparalysis accompany the findings in the midface and orbital region as a result of the pressure of the ossifying ligament on the internal and external carotid arteries and the accompanying sympathetic nerve network [34]. OSL is detected incidentally on panoramic radiographs [33]. In literature, their incidence in panoramic radiography has been reported as 1.4-19.7% [12]. Accurate diagnosis of OSL on panoramic images is sometimes difficult due to the superposition of different bone structures such as the mandible, teeth, or base of the skull. CT and CBCT images provides reliable visualization of the features of the OSL and its



relationship to the surrounding anatomy [35]. In a study comparing the incidence of OSL in panoramic and CBCT images, it was reported that the incidence was 42% on panoramic images and 63% on CBCT images. In addition, it was stated in the study that there was no relationship between the presence of OSL and gender in both imaging methods [35]. Gozil et al. [36] evaluated the relationship of OSL with gender using CT images and reported that OSL generally occurs in male. In our study, as reported by Gozil et al. [36], OSL was statistically higher in males.

Presence of calcified lymph nodes may be a sign of a previously treated pathology or an active disease [2]. Calcified lymph nodes can be identified on routine panoramic radiographs taken in dentistry. On panoramic radiographs, they are observed slightly below the inferior border of the mandible, around the angulus mandible, between the posterior border of the ramus and the cervical vertebrae [13]. In a study evaluating the prevalence of soft tissue calcification/ossification on panoramic radiographs, calcified lymph nodes were reported at a rate of 2.1% [15]. Yalçın et al. [8] reported the frequency of calcified lymph node as 0.2% in the Turkish population on CBCT images. Eisenkraft and Som [37] found 1% cervical lymph node calcification as a result of neck CT examination of 2300 patients, and in our study that conducted on CT images, calcified lymph node was found 0.7%, which is consistent with this study.

There are few studies in literature that retrospectively scanned all head and neck soft tissue calcifications [6,8,11,12,14,15,16,17]. Most studies have examined one or more calcifications [21,24,25,26,28,33,35,37]. The results of our study in this direction could not be fully compared in literature, since it is the first study to look at all types of calcifications in Turkish patients on CT images. In our study, calcification/ossification types which may found in this region such as cysticercosis, phlebolith, laryngeal cartilage calcification, rhinolith, antrolith, myositis ossificans were not detected. When soft tissue calcification/ossification is identified, the primary object is to identify it well and determine if follow-up and treatment is required. Incidentally found soft tissue calcifications/ossifications in the head and neck region are usually followed, but rarely, they can be life-threatening. In parallel with the clinical importance of the lesions, the rate of reporting and follow-up of incidentally detected soft tissue calcifications/ossifications should increase.

## Declaration of Ethical Code

In this study, we undertake that all the rules required to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with, and that none of the actions stated under the heading "Actions Against Scientific Research and Publication Ethics" are not carried out.

Ethics committee approval was obtained for this study with the decision dated and numbered 13.05.2020/114 from Süleyman Demirel University Ethics Committee of Clinical Research.

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