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RESEARCH

The prevalence and clinical importance of incidental soft-tissue findings in cervical CT scans of trauma population

T Ergun* and H Lakadamyali

Department of Radiology, Alanya Teaching and Medical Research Center, Baskent University School Medicine, Alanya, Turkey

Objectives: To define the age-related prevalence of incidental soft-tissue findings in cervical CT scans of a trauma population and to investigate their clinical importance.
Methods: The original diagnostic radiology reports and the CT images of the 357 patients with cervical trauma were retrospectively evaluated. Incidental soft-tissue findings were investigated. All findings were grouped according to age. The findings were classified based on their clinical importance into three categories: Category 1: no clinical importance, Category 2: possible clinical importance requiring further investigation and Category 3: obvious clinical importance. In addition, the medical records of the patients were investigated. The follow-up ratio of the pathologies mentioned in the original radiology report was recorded.
Results: The most frequently encountered findings in Categories 2 and 3 were carotid artery calcification ($n = 89$, 24.9%) and tonsillolith ($n = 115$, 32.2%), respectively. The reporting ratio in the original reports of Categories 1, 2 and 3 findings was 1.1% ($n = 4$), 9% ($n = 27$) and 34.5% ($n = 64$), respectively. No further investigations and follow-up was accomplished for Category 1 lesions, whereas 11.1% of Category 2 and 35.9% of Category 3 lesions were subjected to further investigations and follow-up.
Conclusions: The cervical CT scans of trauma patients reveal many clinically important soft-tissue incidental findings. Cervical region incidental findings may be followed up on an outpatient basis, rarely being of life-threatening value. The ratio of reporting and follow-up of incidental findings increases parallel to the clinical importance of the lesions.
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Introduction

CT has become a reference standard for diagnosing acute injuries of the cervical spine and it is frequently used as an imaging tool in the evaluation of trauma patients because of its ability to definitely demonstrate osseous details.[1]

In addition to trauma-related abnormalities, CT also enables evaluation of other anatomical neck structures. There are plenty of studies evaluating incidental findings on CTs of trauma patients, but those include mainly thoracic, abdominal and cranial abnormalities.[2–7] To the best of our knowledge, there is just one study in the literature where the incidental cervical CT findings of trauma patients were regularly evaluated.[8] In this study, mainly osseous abnormalities and traumatic soft-tissue abnormalities were investigated.

In addition to demonstrating osseous abnormalities, CT can also clearly reveal the normal and pathological anatomy of cervical soft tissues.

The objective of the present study is to define the age-related prevalence of a incidental soft-tissue findings in cervical CT scans of a trauma population and to investigate their clinical importance.

*Correspondence to: Dr Tarkan Ergun, Department of Radiology, Alanya Teaching and Medical Research Center, Baskent University School of Medicine, 07400 Alanya, Antalya, Turkey. E-mail: tarkanergun@yahoo.com
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Materials and methods

Original diagnostic radiology reports and the images from non-contrast cervical CT trauma investigations carried out in the Level 1 trauma centre between 2004 and 2012 were retrospectively evaluated. All trauma patients (*i.e.* blunt *vs* penetrating trauma) who received a cervical CT were included. Individuals with poor scanning range ($n = 44$) who were younger than 16 years of age ($n = 86$) were not included in the study. In addition, osseous abnormalities, traumatic soft-tissue abnormalities, normal anatomic variations and artefacts were not recorded. The remaining 357 patients were included in the study. Of those, 144 were females and 213 were males. Their ages were between 16 years and 92 years, and the mean age was 44.74 ± 18.68 years.

For each of the patients, their cervical anatomy was investigated using both soft tissue and bone windows. Abnormalities related to the thyroid gland, major salivary glands, tongue, larynx, upper trachea and upper oesophagus, parathyroid glands, longus colli muscle tendon and stylohyoid chain were evaluated on axial and two-dimensional-reconstructed sagittal, coronal and oblique CTs of all individuals. The neck region was investigated for the presence of any soft-tissue masses or lymph nodes. The carotid and vertebral arteries were investigated for the presence of any calcifications. In addition, the palatine and adenoid tonsils were evaluated for the presence of enlargement.

The CT investigation was carried out using a single-detector scanner (HiSpeed Advantage SG; General Electric Medical Systems, Milwaukee, WI) and a two-detector MDCT device (Siemens Sensation 4; Siemens, Erlangen, Germany), with the following parameters: slice thickness: 3 mm; mA: 200; V: 120 kVp; pitch: 1–1.5, without contrast administration. The imaging scope was craniocaudal from the occiput down to the T4 level.

The initial evaluation of the CTs was carried out by the staff radiologist. The images were later re-evaluated by two experienced neuroradiologists commonly in conjunction with the patients' clinical history.

An incidental finding was defined as one with no relation to the trauma. The findings were classified based on their clinical importance into three categories.[9–14] (Table 1). A calcified plaque was described as one measuring greater than or equal to 1 mm^2, with a density of over 130 HU. A tonsilolith was consistent with a high-density lesion in the tonsillary area. Calcification of the longus colli muscle tendon was suitable with a high-density area at the tendon fibres of the longus colli muscle tendon. Lymph nodes were also classified into Type 1 category: less than 10 mm for the submandibular and subdigastric regions, and less than 9 mm for the remaining cervical regions; and into Type 3 category: greater than 10 mm, and 9 mm, respectively, in accordance with the report of van den Brekel et al.[15]

The adenoid and palatine tonsils were evaluated to be enlarged or not enlarged. Palatine tonsils met the criteria that published by Donnelly et al[16] for enlargement when they were large enough that a soft-tissue mass was identified extending into the midline images. Adenoid tonsils were evaluated as defined by Fujioka et al[17] On the midsagittal reformatted image, the ratio of the distance between the outermost point of convexity of adenoid shadow and sphenobasiocciput to the distance between sphenobasiocciput and the posterior end of the hard palate were measured (Figure 1). Adenoid tonsils were accepted to be enlarged when the distance between the outermost point of convexity of the adenoid shadow and sphenobasiocciput/the distance between the sphenobasiocciput and the posterior end of the hard palate ratio was higher than 25%.

The demographic properties (age, gender) of the patients were recorded. With respect to data analysis, the patients were divided into 6 groups based on age: Group 1 (16–30 years of age; $n = 94$), Group 2 (31–40 years of age; $n = 87$), Group 3 (41–50 years of age; $n = 47$), Group 4 (51–60 years of age; $n = 45$),

Table 1 Categorization of the incidental findings according to their clinical importance

Category		*Abnormalities*
Category 1	Abnormalities of no clinical importance with no need for further follow-up	Lymph node <1 cm, soft-tissue lipoma, parotid lipoma
Category 2	Abnormalities that are to be further investigated because of possible clinical importance	Stylohyoid ligament calcification, longus colli muscle tendon calcification, tonsillolith, enlarged adenoid or palatine tonsil, soft-tissue cystic mass
Category 3	Abnormalities of obvious clinical importance	Lymph node >1 cm, malignant or premalignant tumours, thyroid abnormality, carotid or vertebral artery calcification, parotid solid masses, parathyroid abnormality

Figure 1 Midsagittal reformatted CT image on bone window demonstrating enlarged adenoid tonsil

Group 5 (61–70 years age; $n = 38$) and Group 6 (71 years of age and above; $n = 46$). The ratio of the presence of findings was calculated for each group. In addition, the medical records of the patients were investigated. The follow-up ratio of the abnormalities mentioned in the original radiology report was additionally recorded.

The relationship between the incidental findings and the age and gender of the patients was evaluated using the *t*-test. A *p*-value of <0.05 was considered significant. The study was approved by the hospital ethics committee. No signed patient consent form was necessary.

Results

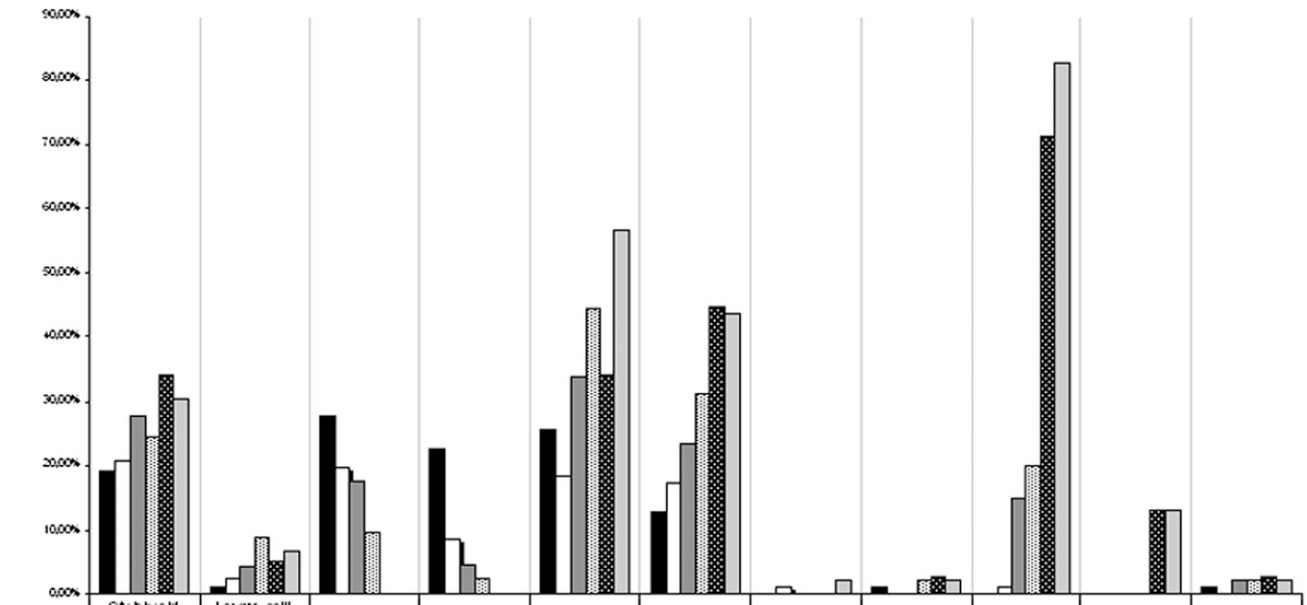
The presence of findings *vs* age of the patients is summarized in Figure 2. The demographic and basic clinical characteristics of the patients are summarized in Table 2.

The reporting ratio in the original reports of Categories 1, 2 and 3 findings was 1.1% ($n = 4$), 9% ($n = 27$) and 34.5% ($n = 64$), respectively. The most frequently reported lesions were thyroid abnormalities ($n = 37$) and carotid artery calcifications ($n = 27$). No further investigations and follow-up was accomplished for Category 1 lesions, whereas 11.1% ($n = 3$) of Category 2 and 35.9% ($n = 23$) of Category 3 lesions were subjected to further investigations and follow-up.

No abnormality was observed in the submandibular glands, tongue, larynx, or at the upper oesophagus or tracheal level. 220 (61.6%) patients had Category 2 findings and 140 (39.2%) had Category 3 findings. In 99 of the patients, both Categories 2 and 3 findings were observed. Category 2 findings were found to be more frequent in males (60.4%) ($p = 0.02$). However, no relation was observed between Category 3 findings and gender ($p = 0.223$). Category 2 findings were more frequently observed in younger patients and Category 3 findings in older ones.

The most frequently encountered finding of clinical importance was thyroid gland abnormality, seen in 89 (24.9%) of the patients (Figure 3). A single nodule was observed in 62 patients, and 19 patients had more than one nodule. In 8 of the patients, the thyroid was enlarged without the presence of any nodule. In 41.5% ($n = 37$) of the patients, the thyroid nodule(s) were also reported in the original radiology report. In 37.8% of those ($n = 14$), a follow-up and further investigations were carried out. 11 of the patients were subjected to pathological evaluation. As a result, in 1 (9%) of the patients, the lesion was reported as malignant, in 8 (73%) it was reported as benign and in 2 (18%) it was reported as non-diagnostic.

A carotid artery calcification was observed in 82 (22.9%) patients (Figure 4). In 73% of the cases, the calcification was bilateral and in 27% it was unilateral. No calcifications



	Stylohyoid ligament calcification	Longus colli muscle tendon calcification	Adenoid	Palatine tonsil	Tonsilloliti	Thyroid pathology	Paratiyroid mass	Parotid mass	Carotid artery calcification	Vertebral artery calcification	Soft tissue mass
I. Group	19,15%	1,06%	27,91%	22,73%	25,53%	12,77%	0,00%	1,06%	0,00%	0,00%	1,06%
II. Group	20,69%	2,30%	19,74%	8,43%	18,39%	17,24%	1,15%	0,00%	1,15%	0,00%	0,00%
III. Group	27,66%	4,26%	17,78%	4,44%	34,04%	23,40%	0,00%	0,00%	14,89%	0,00%	2,13%
IV. Group	24,44%	8,89%	9,76%	2,44%	44,44%	31,11%	0,00%	2,22%	20,00%	0,00%	2,22%
V. Group	34,21%	5,26%	0,00%	0,00%	34,21%	44,74%	0,00%	2,63%	71,05%	13,16%	2,63%
VI. Group	30,43%	6,52%	0,00%	0,00%	56,52%	43,48%	2,17%	2,17%	82,61%	13,04%	2,17%

Figure 2 Graph representing the percentages of incidental findings according to the age group

Table 2 Incidence of incidental findings of the neck area at cervical CT categorized by demographic and basic clinical characteristics of the patients

Category	*Abnormality*	*Female* (n = *144*)	*Male* (n = *213*)	p-*value*
1	Lymph node <1 cm	144 (100.0)	213 (100.0)	1.000
1	Soft-tissue lipoma	0 (0.0)	3 (2.0)	0.154
1	Parotid lipoma	1 (0.6)	2 (0.9)	0.805
2	Stylohyoid ligament calcification	44 (30.5)	43 (20.1)	0.025
2	Longus colli muscle tendon calcification	4 (2.7)	10 (4.6)	0.361
2	Tonsillolith	42 (29.1)	73 (50.6)	0.313
2	Enlarged adenoid tonsil	35 (18.3)	16 (11.6)	0.102
2	Enlarged palatine tonsil	24 (12.1)	6 (4.3)	0.013
2	Soft-tissue cystic mass	0 (0.0)	2 (0.9)	0.245
3	Thyroid abnormalities	42 (29.1)	47 (22)	0.129
3	Carotid artery calcification	34 (23.6)	48 (22.5)	0.813
3	Vertebral artery calcification	3 (2.0)	8 (3.7)	0.371
3	Parotid solid masses	0 (0.0)	1 (0.4)	0.412
3	Parathyroid abnormalities	0 (0.0)	2 (0.9)	0.245

Numbers in parentheses are percentages.

were observed in Group 1. The incidence of plaque calcification was significantly less in individuals younger than 50 years, as compared with those aged 51–60 years, 61–70 years, and 71 years and above ($p < 0.001$, $p < 0.001$, $p < 0.001$, respectively). Vertebral artery calcification was only encountered in individuals older than 60 years (3%, $n = 11$) (Figure 3). All the vertebral artery calcification cases had a concomitant carotid artery calcification.

In 87 (24.3%) of the patients, a stylohyoid chain calcification was observed, mostly (60.9%) bilateral (Figure 5). Stylohyoid chain calcification was more frequent with advanced age, and most frequent in Group 5 (61–70 years of age).

Of the Category 2 lesions, the most frequently encountered one was a tonsillolith [in 32.2% ($n = 115$) of the patients; bilateral in 48 and unilateral in 67 of the patients] (Figure 6). Multiple tonsillolithe were found in 53% of the patients, and single tonsilloliths were found in 47%.

Of the major salivary glands, only the parotid one contained masses: lipoma was found in three (Figure 7) and a solid mass was found in one of the cases.

Soft-tissue masses were observed in five of the cases. Three of those were a posterior located lipoma (Figure 8) and two were smooth-contoured lateral compartment cystic masses.

In two of the cases, masses were observed in the parathyroid glands; one of these was a followed-up parathyroid adenoma (Figure 9). The mass was inferior to the thyroid pole in both of the cases.

Owing to intubation or haemorrhage, adenoid tonsils in 29 patients and palatine tonsils in 20 patients were

Figure 3 Axial unenhanced CT image obtained with soft-tissue window settings demonstrates low-density nodule in the left lobe of the thyroid gland (arrow)

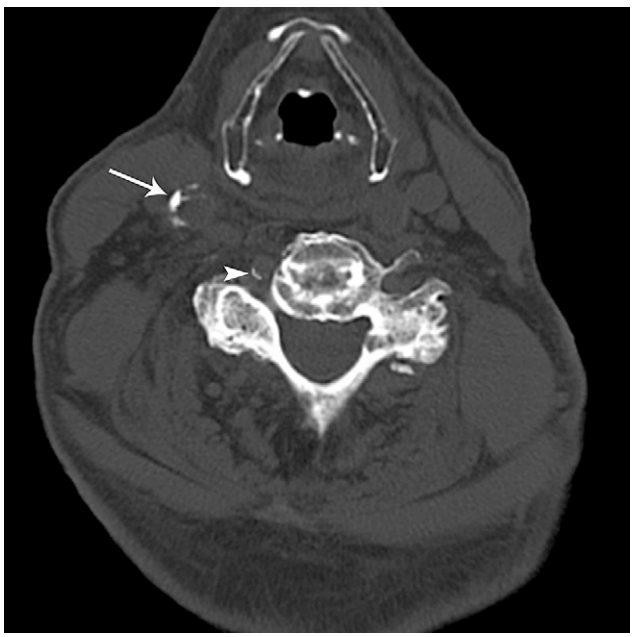


Figure 4 Axial CT image on bone window reveals calcific plaques at the right distal common carotid artery (arrow) and right vertebral artery (arrowhead)

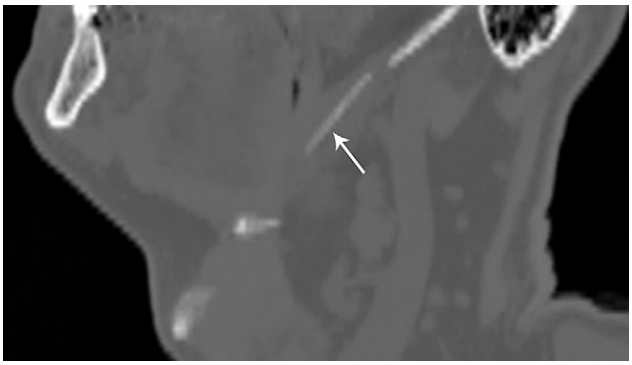


Figure 5 Oblique sagittal reformatted CT image reveal ossification at the left stylohoid ligament (arrow)

not evaluated. Where present, nasopharyngeal tissue thickening was symmetrical in all cases, and no asymmetrical one was observed. The incidences of nasopharyngeal tissue thickening and tonsillary hypertrophy were significantly higher in individuals younger than 30 years than in those older than 30 years of age ($p < 0.001$, $p < 0.001$, respectively) (Figures 1 and 10).

Calcification of the longus colli muscle tendon was observed in 14 patients. In all of them, the calcification was seen at the C1 vertebrae and C1–2 intervertebral disc level. The calcification was bilateral in 11 and unilateral in 3 cases (Figure 11).

All individuals had at least five lymph nodes. None of them were Category 3 findings. Individuals of the 16–30 years and 31–40 years age groups had more lymph nodes than those in the rest of the age groups. However, the difference was not statistically significant ($p = 0.133$).

Figure 6 Axial unenhanced CT image obtained with bone window settings shows a lobulated, hyperdens ovoid mass in the left tonsil (arrow)

Figure 7 Axial unenhanced CT images on soft-tissue windows reveal well-defined fat density solid mass within the superficial lobe of the left parotid gland (arrow)

Figure 8 Axial unenhanced CT images on soft-tissue window revealing lipoma within the left posterior cervical area (arrow)

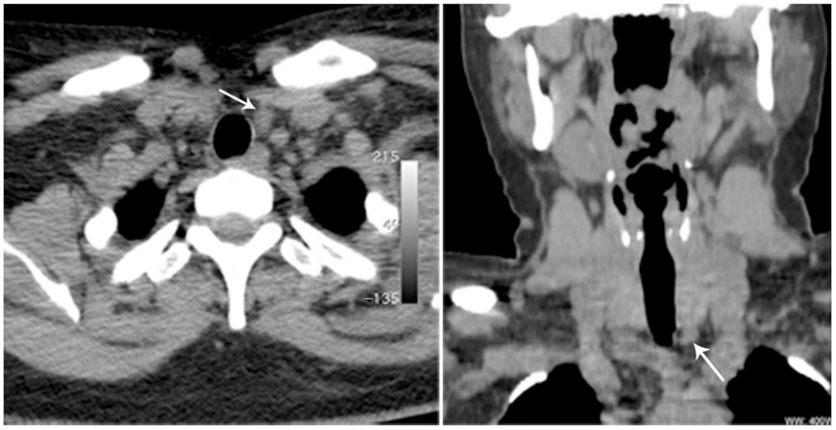


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Figure 9 Axial (a) and coronal reformatted (b) unenhanced CT image obtained with soft-tissue window settings shows a 1 cm solid mass at the lower pole of the thyroid gland, consistent with a known parathyroid adenoma (arrow)

Discussion

Clinically important incidental findings were observed in 261 of the 357 retrospectively evaluated patients. According to previous publications, most of the abdominal and thoracic incidental findings in trauma populations were benign.[6,7] The present study demonstrated similar findings with relation to the cervical region, where the incidental findings turned out to be mostly benign.

Incidental findings were reported in the literature to be higher with advanced age.[2,7] The present study found the Category 2 lesions to be more frequent in younger patients, whereas Category 3 lesions were more frequent in older patients. The association between incidental findings and gender in trauma populations was reported to be different in various studies. Although Barboza et al[8] did not find any association, Barrett et al[7] and Paluska et al[2] reported the incidental findings to be more frequent in females. Our study demonstrated no association between Category 3 lesions and gender ($p = 0.233$); however, Category 2 lesions were found to be more frequent in males ($p = 0.02$).

The present study, despite the relatively small number of cases, is that it demonstrated the age group distribution of the frequency of the abnormalities of cervical non-osseous anatomic structures in trauma patients upon their specific evaluations. In contrast to the study conducted by Barboza et al,[8] the present study found many soft-tissue anomalies that are (thyroid abnormality 24.9%, carotid artery calcification 22.9%, vertebral artery calcification 3%) or might be (tonsillolith 32.2%, stylohyoid ligament calcification 24.3%, adenoid 15.5%, palatine tonsil 8.9%) of clinical importance.

Munk et al[6] found 15% ($n = 41$) life-threatening lesions in the cranial, thoracic, abdominal and vertebral column CTs of the trauma patients in their study. No life-threatening abnormalities were observed in the cervical soft tissues of the cases in our study. Our study revealed many clinically important and non-important incidental cervical soft-tissue findings. The reporting ratios in the original reports of Categories 1, 2 and 3 lesions were 1.1%, 9% and 34.5%, respectively. The failure to report or to properly follow up, especially with the clinically important findings, may lead to worsening of the condition as well as to medico-legal problems. Munk et al[6] reported 49% and Messarsmith et al[18] reported 18% follow-up ratios for the clinically important

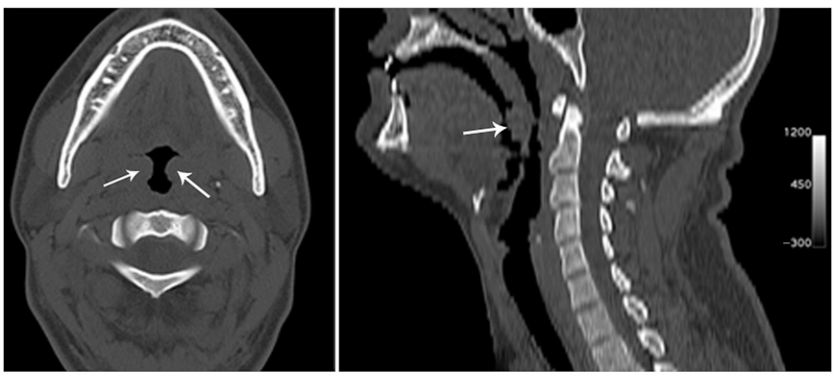

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Figure 10 Axial (a) and sagittal reformatted (b) unenhanced CT images on bone windows revealing enlarged palatine tonsils (arrows)

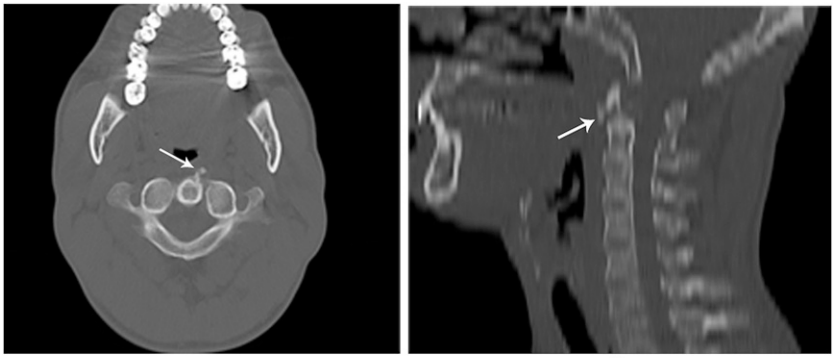

Figure 11 Axial (a) and sagittal reformatted (b) unenhanced CT images on bone windows show the amorphous calcification within the superior tendons of the left longus colli muscle at the C1–C2 level (arrows)

findings. In our study, however, the follow-up ratio of the Category 3 findings was 35.9%.

Our study had several limitations. Firstly, it was conducted in a single centre, and the regional patient population may have different risk factors than that of other regions. Thus, the results may not be applicable to all hospitals, and their validity may be limited. The second drawback is the limitation of non-contrast CT scans with regard to detecting lesions in parenchymatous organs when compared with contrast CTs and ultrasonography. The third limitation is the evaluation difficulty caused by bone-related (clavicle, mandible, skull base) beam-hardening artefacts, especially with regard to the upper and lower cervical region and dental impression materials-related metal artefact, especially with regard to the upper cervical region. The last limitation is that histopathological examination was not performed in all patients.

As a result, the cervical CT scans of trauma patients reveal many clinically important soft-tissue incidental findings. Cervical region incidental findings may be followed up on an outpatient basis, rarely being of life-threatening importance. The ratio of reporting and follow-up of incidental findings increases parallel to the clinical importance of the lesions.

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