



## Case Report

# Micro computed tomography features of laryngeal fractures in a case of fatal manual strangulation



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## ABSTRACT

Cases of subtle fatal neck compression are often complicated by the lack of specificity of the post-mortem signs of asphyxia and by the lack of clear signs of neck compression.

Herein we present a forensic case of a 45-year-old schizophrenic patient found on the floor of the bedroom of a psychiatric ward in cardiopulmonary arrest and who died after two days in a vegetative state. The deposition of the roommate of the deceased, who claimed responsibility for the killing of the victim by neck compression, was considered unreliable by the prosecutor.

Autopsy, toxicological analyses, and multi-slice computed tomography (MSCT), micro computed tomography (micro-CT) and histology of the larynx complex were performed. Particularly, micro-CT analysis of the thyroid cartilage revealed the bilateral presence of ossified triticeous cartilages and the complete fragmentation of the right superior horn of the thyroid, but it additionally demonstrated a fracture on the contralateral superior horns, which was not clearly diagnosable at MSCT. On the basis of the evidence of intracartilaginous laryngeal hemorrhages and bilateral microfracture at the base of the superior horns of the larynx, the death was classified as a case of asphyxia due to manual strangulation.

Micro-CT was confirmed as a useful tool in cases of subtle fatal neck compression, for the detection of minute laryngeal cartilage fractures, especially in complex cases with equivocal findings on MSCT.

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## 1. Introduction

Anoxial deaths are among the most enigmatic of all forensic phenomena that routinely confront the pathologist, as there is no fully determinate post-mortem sign of asphyxia [1]. Indeed, macroscopic or histological findings, such as cyanosis, fluidity of blood, pulmonary congestion and edema, dilation of the right ventricle and petechiae, are considered unspecific signs of asphyxia [2,3]. Although in cases of strangulation the diagnosis of an asphyxial death may be simple, because of neck injuries associated with neck compression [4], in particular cases (i.e. “subtle fatal neck compression”) the absence of overt mechanical injuries to the neck may make diagnosis difficult [1].

In such cases, a thorough analysis of all the available circumstantial, radiological, necroscopic and toxicological data is essential to establish the cause and the dynamic of death.

Herein we present a forensic case of fatal manual strangulation, where multi-slice computed tomography (MSCT), micro computed tomography (micro-CT) and histological features of laryngeal fractures are described and compared.

## 2. Case report

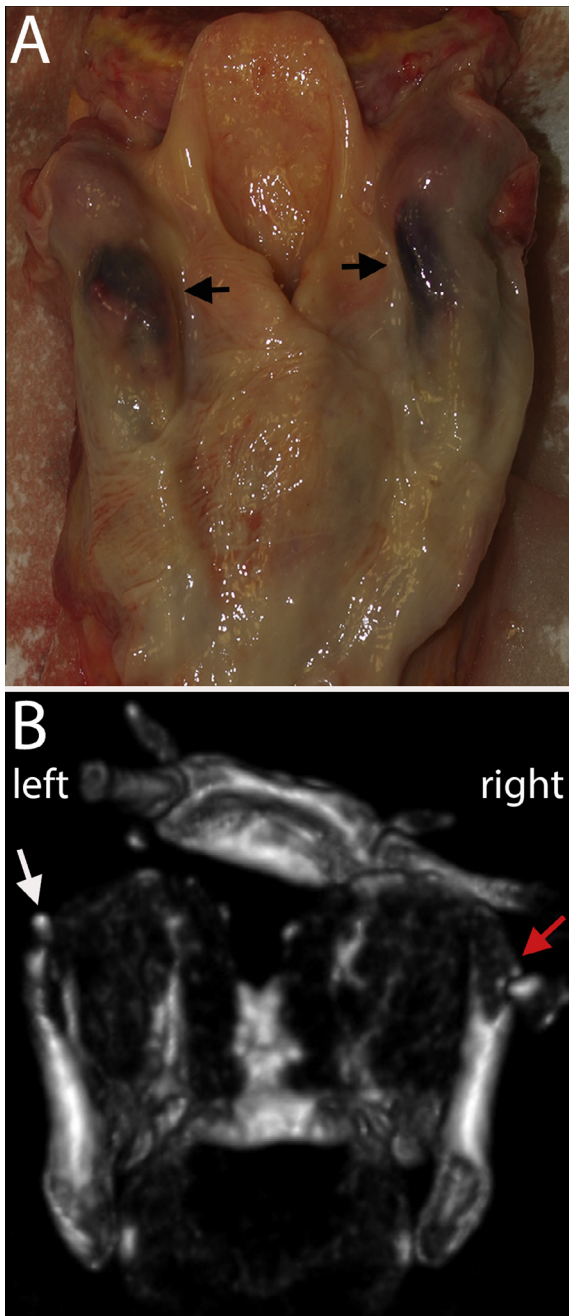
A 45-year-old schizophrenic patient was found on the floor of the bedroom of a psychiatric ward in cardiopulmonary arrest. Despite successful resuscitative maneuvers, brain death was declared after two days in a vegetative state. The roommate of the victim, who was also schizophrenic, stated that “the voice of God told me to kill my roommate”, “I have strangled him” and “death occurred after a prolonged scuffle”. The aggressor did not present any external lesions.

### 2.1. Autopsy

At the dissection of the neck, hemorrhagic infiltration of the mucosa overlying the superior horns of the thyroid larynx were detected (Fig. 1A). Some internal aspecific signs of asphyxia, such

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**Fig. 1.** Macroscopic and MSTC images of the larynx complex. (A) At gross examination, bilateral hemorrhagic infiltration of the soft tissues of the mucosa overlying the superior horns of the thyroid larynx (black arrows) were evident. (B) 3D reconstruction of the MSTC images showing bilateral ossification of the triticeous cartilages (white arrow) and the presence of multiple displaced fragments in the right superior horn of the thyroid cartilage (red arrow). The image has been rotated just in order to make it exactly specular to the anatomical images. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

as hyperemia of internal organs, bloodless spleen, pulmonary hyperinflation, as well as epicardial and pleural petechiae were observed. The cardiopathological analysis displayed a three-vessel coronary artery disease.

## 2.2. Radiology

Since it was not possible to perform post-mortem radiological investigations of the whole body before the autopsy, during the

visceration, the thoracic block (tongue, neck structures, heart, lungs and mediastinum) was removed, collected and fixed in 4% neutral formaldehyde solution. Subsequently, a CT scan of the isolated larynx was performed by a 64 MSCT (Philips Brilliance, Philips, Eindhoven, the Netherlands; 120 kV, 36 mA, 2 mm slice thickness, spacing between slices 1.0 mm). The 3D reconstruction of the CT images demonstrated the bilateral ossification of the triticeous cartilages and the presence of multiple displaced fragments in the right superior horn of the thyroid cartilage (Fig. 1B). On the left side, there was no clear radiological evidence of radiopaque fragments or interruption of the continuity of the ossified cartilage of the horns.

Furthermore, the larynx was scanned using a Skyscan 1172 HR micro-CT (Skyscan, Aartselaar, Belgium; 15  $\mu$ m isotropic voxel size, kV 65, uA 153, exposition time 1210 ms, rotation step 0.4, frame averaging 2, 1280  $\times$  1024 pixel Field of View). Because the maximum object size of this micro-CT is 27 mm in diameter, both superior thyroid horns and lateral thyrohyoid ligaments were carefully excised, located separately in a vertical position inside a cylindrical polyethylene container (sample size: 2  $\times$  1 cm) and separately scanned. Reconstructions were performed by N-Recon Software and 3D images were obtained by CT-Vox Software (Skyscan, Aartselaar Belgium).

The micro-CT scans confirmed the presence of ossified triticeous cartilages and the complete destruction of the right superior horn of the thyroid (Fig. 2C and D). Moreover, an oblique linear fracture of the left superior horn surrounded by multiple minute fragments was identified (Fig. 2A and B, red arrow).

## 2.3. Histopathology

Both superior thyroid horns were decalcified for 48 h in a mixture of methanol 5%, formic acid 10% and formaldehyde 15%. The specimens were embedded longitudinally in paraffin, sectioned by microtome in 5- $\mu$ m slices, de-paraffined, hydrated with distilled water, stained with hematoxylin–eosin, and examined with a Leica DM-4000B optical microscope (Leica, Cambridge, UK). In both samples, hemorrhage of the soft tissues, macrophage infiltration and a fibrin network between the ossified fragments were noted (Fig. 3).

## 2.4. Toxicology

Toxicological analyses were performed on a blood sample collected immediately after the victim's finding on the floor of the bedroom. Analytical results were as follows: benzodiazepines (oxazepam, temazepam, medazepam, nordazepam and diazepam) and antipsychotics (haloperidol, biperiden and clotiapine) within or below the therapeutic range.

## 3. Discussion

Cases of subtle fatal neck compression are often complicated by the aspecificity of the post-mortem signs of asphyxia and by the lack of clear signs of neck compression [1].

In the reported case, the deposition of the roommate of the deceased, who declared the killing of the victim by neck compression after a prolonged scuffle was considered unreliable by the prosecutor, because of his schizophrenic disorder as well as the lack of external lesions on the bodies of the aggressor and of the victim.

Moreover, it seemed likely that the resuscitation maneuvers and the prolonged vegetative state produced the post-mortem signs of asphyxia which was detected during the autopsy (i.e. hyperemia

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