The role of virtopsy in the interpretation of fatal collisions involving motor-vehicle accidents

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Aims and objectives

Aim of our study is to establish the role of virtopsy in the evaluation of lesion's pattern, cause of death, and particularly in the recognition of dynamics of trauma, in victims of fatal motor-vehicle accidents.

In motor-vehicle accidents, different mechanical stress might cause different injuries, depending on the modality of trauma.

Upright pedestrians presents primary and secondary impact lesions. Usually primary lesion is in the lower legs at different heights (depends on bumper's heights). Secondary lesions normally occur in pelvic bones and skull. Otherwise recumbent pedestrians show internal organs and rib cage compression lesions.
Methods and materials

From January 2012 to October 2104 we evaluated four corpses, two pedestrians, one cyclist and one motorcyclist, in whom the death cause and trauma dynamics were unclear.

In these patients we performed a whole body (apex-feet) spiral CT acquisition with a thin-section 16 raw CT scanner (Toshiba Aquilion), in order to perform high resolution three-dimensional and multiplanar reconstruction.

We used a total beam collimation of 16x1mm, reconstruction thickness 1mm, reconstruction interval 1mm, kVp 120, mA 250, pitch 1,531, and standard reconstruction algorithm.

CT findings have been analyzed to distinguish previous or acute bone lesions; to evaluate internal organs, recognize and localize foreign objects and to discover vital signs present at the moment of trauma.
Results

We evaluated a case of upright pedestrian, a case of recumbent pedestrian, a case of cyclist and a motor-biker.

The first case involved an upright pedestrian, a man of 35, who was crashed by a car bumped in an accident. The forensic external examination showed only signs of preternatural mobility of the rib cage, suspicious for bilateral ribs fractures, anterior chest wall deformity and subcutaneous emphysema.

Virtopsy showed right heart's rupture, massive bilateral hemothorax, subcutaneous emphysema Fig. 1 on page 6 right pneumothorax Fig. 2 on page 6 and multiple pelvic Fig. 3 on page 7 and rib's fractures Fig. 4 on page 8.

In this case, the autopsy was not requested by the competent authorities and CT alone allowed to identify a precise cause of death.

The second case was a 16 years old boy found dead on the sidewalk: the only evidence at forensic external examination was a contused lacerated wound on the right flank Fig. 5 on page 9.

In this case there weren't obvious external injuries allowing to hypothesize the cause of death.

Dynamics and cause were clarified by CT acquisition which showed a typical run over lesion's pattern: multiple right rib's fractures, from IV to VIII Fig. 6 on page 10, bilateral lung contusions and lacerations Fig. 7 on page 11, hematoma, pneumothorax Fig. 8 on page 12/Fig. 9 on page 13, subcutaneous emphysema and suspicious right hepatic fracture corresponding to the excoriated wound detected at the right flank Fig. 10 on page 14. Endoabdominal blood-density effusion was also detected Fig. 11 on page 15.

It was possible to deduce that the boy was already lying at the time of the trauma, in addiction alcohol level was high.

The third case was a cyclist, found dying by rescuers on the site of the accident. The post-mortem forensic external examination reported: wound at the level of the ear Fig. 12 on page 16; lacerated contused wounds at the level of the left shoulder Fig. 13 on page 17, in the left antero-superior iliac spine Fig. 14 on page 18, at right chest and flank Fig. 15 on page 19. These corresponded, at lung CT scan, to pulmonary lacerations and contusions with large hematoma Fig. 16 on page 20 / Fig. 17 on page 21.
Virtopsy demonstrated also the extension of subcutaneous emphysema involving the entire right side: from the right flank to the chest wall Fig. 18 on page 22, lung hematoma was confirmed at macroscopic analysis Fig. 19 on page 22.

Virtopsy overall lesion's pattern of the cyclist oriented for a primary impact on the left side and secondary right contusion causing death. This allowed to infer that the cyclist was on the pavement before truck impact, according to driver declaration that he could not avoid him.

The last case was a motorcyclist dead after the impact with a car. The forensic external examination showed: bilaterally lacerated contused wounds of the face (major on the left side, with signs of emission of blood from nose and mouth); signs of cervical spine dislocation and of preternatural mobility of the rib cage (suspicious for bilateral ribs fractures); left flank lacerated contused wounds; fractures of the legs at lower third.

Skull's CT scan showed sphenoid bilateral fractures; right avulsion of the odontoid process Fig. 20 on page 23; fracture of the left cheekbone Fig. 21 on page 24, ematic fluid in the left maxillary sinus and subarachnoid blood effusion. Virtopsy confirmed also the suspected fractures of the rib cage Fig. 22 on page 25, and highlighted the presence of dislocation to the right of all distal bone fractures fragments, in particular bilaterally at the level of the tibia and fibula Fig. 23 on page 26.

The study of the internal organs showed: massive bilateral hemothorax, greater on the right side, with irregular profile of aorta and superior vena cava Fig. 24 on page 27; presence of mediastinic and peritoneal blood, spleen and left kidney fractures Fig. 25 on page 28.

The presence of spleen and left kidney fractures associated with L1 fractures; left pelvic Fig. 26 on page 29, left cheekbone fractures, and the presence of right dislocation of distal segments of all fractures, allowed us to infer that the greater impact had occurred from the left side.

What was possible to deduce from CT, analyzing the fracture's pattern, has provided an 'evidence' which agrees with driver declaration that the motorcyclist entered on the road quickly and that he could not avoid him.
Images for this section:

Fig. 1: Axial CT image showing subcutaneous emphysema evident at the right side of the chest and massive bilateral hemothorax

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Fig. 2: Axial CT image showing right pneumothorax, subcutaneous emphysema and massive bilateral hemothorax

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**Fig. 3:** Oblique right lateral 3D VR CT image reconstruction showing right ileo-pubic and ischio-pubic branches fractures

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Fig. 4: Oblique posterior 3D VR CT image reconstruction showing multiple rib's fractures

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Fig. 5: Corpse finding after rescuers intervention

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Fig. 6: Oblique right lateral 3D VR CT image reconstruction showing multiple rib's fractures from IV to VIII

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Fig. 7: Axial CT image showing bilateral lung contusions and lacerations

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Fig. 8: Axial CT image showing right pneumothorax, bilateral lung contusions and lacerations

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Fig. 9: Axial CT image showing the presence of hematoma of the lung

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**Fig. 10:** Axial CT image showing suspicious right hepatic fracture in the posterior part of the right lobe and subcutaneous emphysema

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**Fig. 11:** Coronal MultiPlanar Reconstruction (MPR) of the body showing endoabdominal blood effusion

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Fig. 12: Image showing the patient's wound at the level of the ear

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Fig. 13: Image showing the patient's lacerated and contused wound at the level of the left shoulder

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**Fig. 14:** Image showing the patient’s lacerated and contused wound at the level of the left flank (antero-superior iliac spine)

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Fig. 15: Image showing the patient's lacerated and contused wound at the level of the right chest and flank

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**Fig. 16:** Axial CT image showing subcutaneous emphysema evident at the right side of the chest, pulmonary hematoma, lacerations and contusions

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**Fig. 17:** Axial CT image showing large pulmonary hematoma
**Fig. 18:** Coronal MPR of the body showing large pulmonary hematoma and subcutaneous emphysema more evident on the left flank

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**Fig. 19:** Image of the lung showing large pulmonary hematoma

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Fig. 20: Sagittal MPR of the head showing fracture of the odontoid process

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Fig. 21: Oblique left lateral 3D VR CT image reconstruction showing fracture of the left cheekbone

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Fig. 22: Oblique left lateral 3D VR CT image reconstruction showing multiple left rib’s fractures

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**Fig. 23:** Oblique right lateral 3D VR CT image reconstruction showing bilateral tibia and fibula fractures with dislocation to the right of distal bone fracture's fragments

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**Fig. 24:** Axial CT image showing massive bilateral hemothorax, greater on the right side, with irregular profile of aorta and superior vena cava

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Fig. 25: Axial CT image showing peritoneal blood, spleen, left kidney and vertebral fractures

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**Fig. 26:** Oblique right lateral 3D VR CT image reconstruction showing left ileo-pubic and ischio-pubic branches fractures

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Conclusion

Virtopsy is useful for the identification and determination of crash lesion’s patterns and for reconstructing events.

Virtopsy, performed previously to the autopsy, allows to highlight the effects of traumatic injury on corpses, even in more complex access autopsy locations. Multiplanar CT reconstructions help in the evaluation of fractures and then to reconstruct the likely impact modality of the body in case of motor-vehicle accidents.

Virtopsy is a reliable non-invasive method that can be considered useful to guide a focused autopsy, and is able to provide documentation assessable at successive times, even after the body has been cremated or buried. It should not be considered a substitute, but a complementary forensic investigation, to strengthen and improve the quality of the judicial autopsy.
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