Cureus
Part of SPRINGER NATURE

Open Access Case Report

Anatomy of a Gunshot: Complementary Findings From Post-mortem Computed Tomography and Autopsy in a Fatal Thoracic Firearm Injury

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Review began 09/04/2026
Review ended 10/15/2026
Published 10/21/2026

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DOI: 10.7759/cureus.118347

Abstract

Forensic interpretation of firearm injuries requires careful separation of observed pathology from inferences about firing distance, projectile behaviour, and the circumstances of discharge. We describe the investigation of a fatal penetrating thoracic firearm injury in a 27-year-old woman examined using post-mortem computed tomography (PMCT) and conventional medicolegal autopsy. A single oval entry wound, measuring 1.6 × 1.0 cm, was present over the right parasternal region at the level of the third costal cartilage, with an eccentric abrasion collar. Multiple punctate skin lesions described as powder tattooing were distributed over exposed areas, particularly the dorsum of the right hand and distal forearm, and over the anterior neck and lower face; relative sparing was noted beneath the upper garment. Autopsy documented a broadly posterior, inferior, and leftward wound pathway involving the right lung, pericardium, major thoracic vessels, right main bronchus, and thoracic vertebrae. A deformed jacketed projectile was recovered from the left posterior thoracic wall. PMCT localised the retained projectile and demonstrated thoracic vertebral injury before dissection. Fatal haemorrhage from major intrathoracic injuries was the principal pathological finding. The pattern of skin lesions is compatible with exposure to discharge-associated particulate material, but a precise muzzle-to-target distance, firearm classification, and body position cannot be determined from the reported data. This case illustrates the complementary roles of imaging and autopsy and the need to express reconstructive conclusions according to the strength and limitations of the actual observations.

Categories: Trauma, Forensic Medicine
Keywords: autopsy, computed tomography, firearms, forensic pathology, gunshot wounds, homicide, thoracic injuries

Introduction

The examination of a fatal firearm injury has two related, but different, objectives: identifying the anatomical injuries responsible for death and assessing what those findings may contribute to reconstruction of the shooting event. External wound morphology, clothing defects, particulate deposits, skeletal damage, internal wound pathways, and recovered projectiles can each inform this assessment. Their interpretations nevertheless depend on conditions that may not be apparent from autopsy alone, including firearm and ammunition characteristics, intervening materials, body movement, and the investigative setting [1-3].

Post-mortem computed tomography (PMCT) adds a non-destructive record of skeletal injury, radiopaque foreign bodies, and their spatial relationships. It can assist with projectile localisation before dissection, although soft-tissue injury to vessels, airways, and organs may still require direct autopsy examination [4,5]. Imaging, wound inspection, and laboratory ballistics therefore answer overlapping but nonidentical questions.

The present case is educational because an externally documented anterior chest entry wound was associated with a complex intrathoracic injury pathway, a retained projectile, and geographically separated punctate skin lesions. It also illustrates a common interpretive hazard: a credible anatomical account of a projectile pathway does not necessarily establish the firing distance, the orientation of the shooter and victim, or the dynamic behaviour of a bullet after striking bone. We present the observed findings first and then discuss the limited conclusions they support.

Case Presentation

Circumstances and examination

A 27-year-old woman was brought dead to the trauma centre of a tertiary-care institution in northern India after an alleged firearm assault. Information supplied to the medical team indicated that she had been found unresponsive in her residence. A medicolegal autopsy was undertaken as part of the subsequent

investigation. The account of an assault derives from investigative history and should not be mistaken for an independent pathological determination of the manner of death.

The body was clothed in a brown, full-sleeved thermal upper garment, blue-and-white striped pyjama trousers, and black thermal lower clothing. A single perforation of the upper garment corresponded in location to an external wound on the right anterior chest (Figure *1*). The source report did not give a mapped or laboratory-confirmed description of particles or soot on the garment, its fit or position during the shooting, or the precise relationship between the fabric and underlying skin.



FIGURE 1: Garment and external thoracic findings.

Panel A: upper garment with right-sided perforation; Panel B: anterior thorax with right parasternal wound and regional punctate lesions.

External examination

A solitary oval wound measuring 1.6 × 1.0 cm was identified in the right parasternal region at the level of the third costal cartilage (Figure *2*). The reported features included inverted margins, associated bluish contusion, and an abrasion collar more prominent inferolaterally. No external exit wound was identified.



FIGURE 2: Close-up of the right parasternal entrance-type wound, showing oval configuration, inverted margins, contusion, and inferolaterally accentuated abrasion collar.

Numerous punctate lesions, described at the original examination as powder tattooing, were documented most prominently over the dorsum of the right hand and distal forearm, with a less dense distribution over the anterior neck and lower face (Figures *1*, *3*). The skin covered by the thermal garment around the chest wound appeared relatively spared. This distribution is a direct morphological observation; whether each lesion represents embedded propellant material, and the precise mechanism of its distribution, were not independently confirmed by a reported histological, chemical, or laboratory analysis.



FIGURE 3: Punctate lesions documented on (A) the dorsum of the right hand/distal forearm and (B) the anterior neck/lower face. These are morphologically described as tattooing; composition was not established in the submitted material.

Pre-autopsy imaging

PMCT was performed before autopsy. The submitted account documents three-dimensional volume-rendered images showing the retained radiopaque projectile in the left posterior thoracic region and an injury involving the sixth and seventh thoracic vertebrae (Figure *4*). These findings were subsequently correlated with dissection. The submitted source does not report the scanner model, acquisition parameters, reconstructed slice thickness, or a systematic image-by-image evaluation of the thoracic soft tissues; these details should be added from the original imaging record if retrievable. The available Figure *4* should not be represented as independently depicting the entire soft-tissue bullet track.

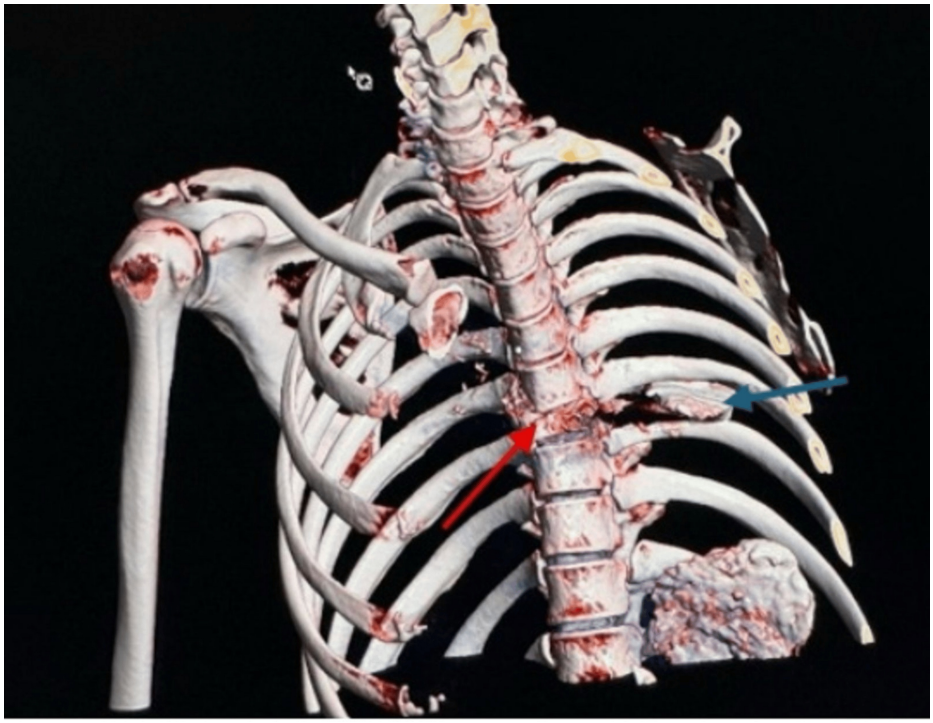


FIGURE 4: Three-dimensional volume-rendered PMCT image showing a thoracic vertebral fracture-dislocation (red arrow) with an in situ projectile in the left seventh intercostal space (blue arrow), highlighting the utility of PMCT in evaluating complex thoracic skeletal injuries.

PMCT: post-mortem computed tomography

Internal examination and recovery of the projectile

Dissection documented perforating injury beginning at the right third sternochondral junction and continuing through the right lung middle lobe, pericardium, ascending thoracic aorta, right main bronchus, and descending thoracic aorta, together with injury to the sixth and seventh thoracic vertebrae (Figures *5*-*6*). The general orientation of the documented pathway was posterior, inferior, and toward the left. These structures are listed in the order given by the submitted autopsy narrative; a precisely timed sequence of every intermediate tissue impact, or discrete direction changes at each bony contact, cannot be established from that narrative alone.

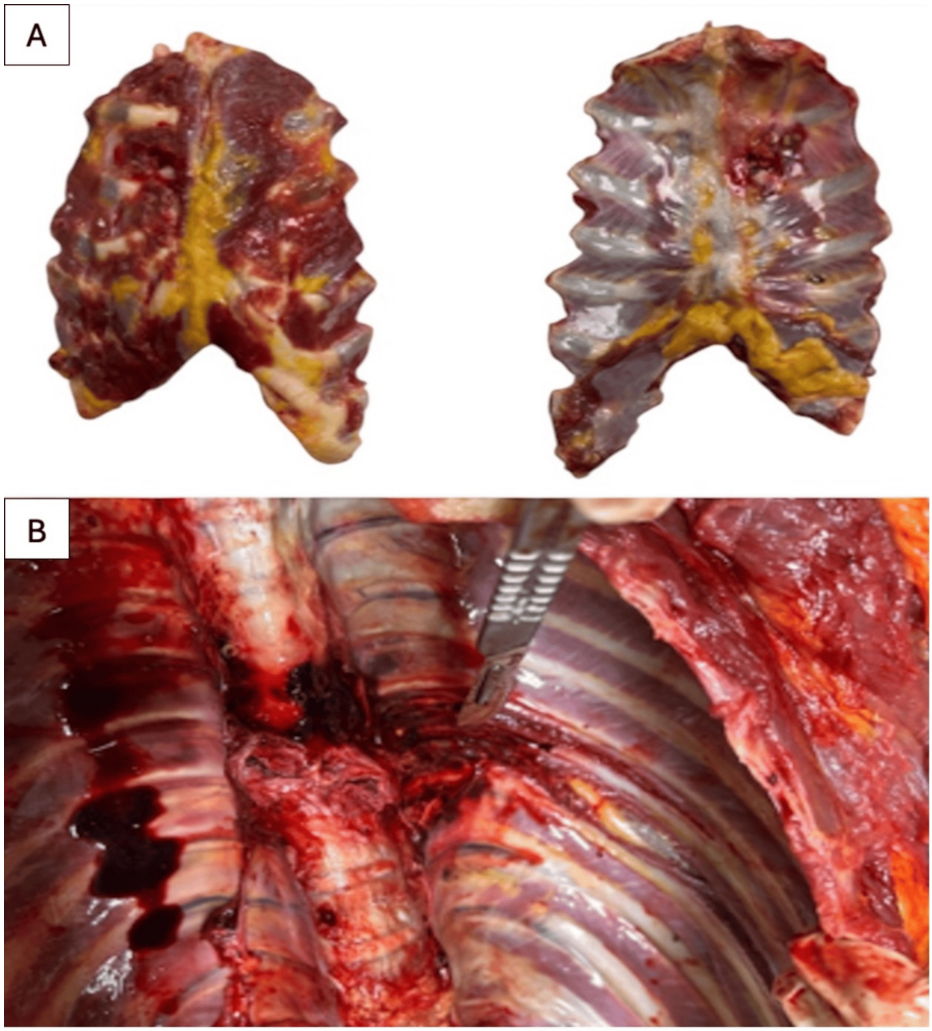


FIGURE 5: Thoracic skeletal findings: (A) right anterior thoracic cage with injury at the third sternochondral junction, shown from the indicated external and internal perspectives; (B) posterior thoracic wall with T6-T7 injuries and retained projectile location.

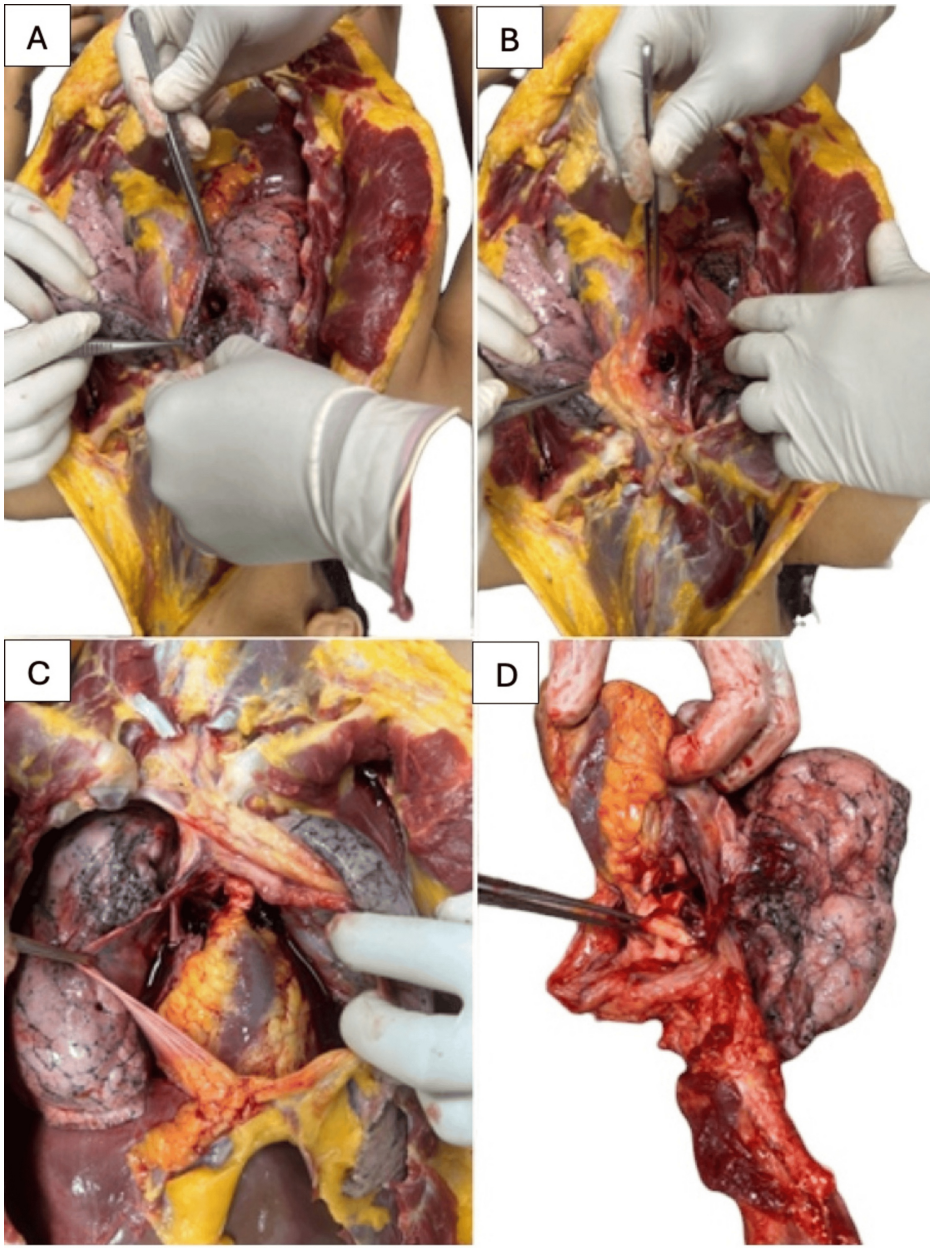


FIGURE 6: Dissection demonstrating the bullet track through the mediastinum.

(A, B) Exploration of the projectile tract involving the ascending thoracic aorta and right main bronchus. (C) Thoracic cavity after en bloc organ removal showing the mediastinal bullet track. (D) En bloc heart-lung specimen demonstrating the perforating injuries involving the ascending thoracic aorta and right main bronchus.

Approximately 950 mL of blood was reported in the right pleural cavity and 40 mL in the pericardial sac. A deformed jacketed projectile was recovered from the left posterior thoracic wall at the level of the seventh intercostal space, without a corresponding external exit wound (Figure 7). The thoracic skeletal injury and the terminal projectile location corresponded with the pre-autopsy PMCT observations.



FIGURE 7: Deformed jacketed bullet recovered from the posterior thoracic wall during autopsy, shown alongside a metric scale.

The projectile, clothing, and other appropriate forensic specimens were described as preserved and sealed for laboratory examination. No laboratory report identifying firearm type, calibre, projectile striations, residue composition, weapon-to-projectile association, or experimental firing-distance comparison is reproduced in the source. Their examination status and results must be confirmed with the investigating authority; absent such documentation, they cannot be used as evidence for a particular firearm or firing distance.

Cause and manner of death

The pathological findings support death due to severe haemorrhage resulting from a penetrating firearm injury of the thorax with disruption of major intrathoracic vessels and associated pulmonary and mediastinal structures. Haemorrhagic shock is the likely physiological mechanism. The original report classified the death as homicide in the setting of a medicolegal investigation; that investigative classification is reported here as contextual information and is not inferred solely from the wound morphology.

Discussion

What the external findings establish and what they do not

An entrance wound is supported by the right anterior chest defect with inverted margins, a surrounding abrasion collar, and an internal pathway terminating in a retained projectile. An eccentric abrasion collar is compatible with nonperpendicular impact, but collar geometry is affected by local skin tension, contour,

deformation, and projectile-tissue interaction. It cannot independently determine a numerical angle of incidence, and “inferolateral” describes the location of collar accentuation rather than a proven vector of projectile flight [1-3].

Punctate skin injuries interpreted as propellant tattooing can be consistent with exposure to particulate material expelled during firearm discharge. Their distribution may suggest relative muzzle proximity under suitable circumstances, yet characteristic appearances and effective deposition distances vary with the weapon, ammunition, intervening garment, and environmental conditions [2,6-8]. The absence of reported soot, scorching, or a muzzle imprint neither establishes a particular named range category nor excludes every form of relatively close discharge. We therefore avoid the categorical labels “near-range,” “close-range,” or “distant” for this case. A specific distance would require appropriate comparison testing and interpretation by a firearm examiner, ideally using the implicated firearm, ammunition, and relevant intervening materials.

The relative sparing of skin beneath the thermal garment is compatible with partial interception of airborne particulate material by the fabric, sometimes described descriptively as a clothing-shadow pattern. However, the garment’s exact configuration at discharge and the residue distribution on the garment were not documented sufficiently to establish that explanation. It is presented as a possibility, not as proof of a particular clothing position or firing distance.

The marked concentration of punctate lesions on the dorsal right hand and forearm deserves specific documentation but cannot provide a reliable three-dimensional reconstruction of upper-limb position. Direct exposure of those surfaces to discharge-associated particles is one possible explanation. Other possibilities include limb movement, particle redistribution, or transfer in the immediate environment, and none can be discriminated using the photographs and narrative alone. In particular, no defensive gesture, struggle, or fixed hand-to-chest relationship is established by these lesions.

Projectile pathway and the limitations of dynamic reconstruction

The entrance and termination sites, together with the observed internal injuries, support a general course from the right anterior thorax toward the left posterior thorax, with inferior and posterior components. Injury at the sternochondral junction and vertebrae confirms contact with bony structures. It does not, by itself, prove a ricochet or identify the degree and timing of any deflection. Changes in direction after skeletal impact are possible, but require more specific trajectory mapping or ballistic evidence before they can be assigned to a particular mechanism.

Similarly, continuity of a dissected wound pathway does not establish that the projectile travelled without yaw, tumble, substantial deformation, or transient cavitation. The recovered bullet was described as deformed and jacketed. Its retention indicates that the projectile came to rest after traversing the body, but neither terminal position nor deformation alone identifies muzzle velocity, weapon category, or rifling characteristics [2,9]. A formal firearm and ammunition examination is necessary for more specific assertions about the weapon and projectile.

Distinct contributions of PMCT and autopsy

The clearest documented contribution of PMCT in this case was pre-dissection localisation of the projectile and depiction of thoracic vertebral injury. These observations could aid planning and provide a permanent three-dimensional record [4]. Conventional autopsy established the detailed soft-tissue injuries, including damage to the lung, pericardium, bronchus, and aorta, and documented intrathoracic blood collections. The manuscript does not demonstrate that PMCT alone traced each soft-tissue component of the wound pathway or that it reduced the extent of dissection. The modalities should therefore be described as complementary rather than mutually validating every reconstructive inference.

PMCT has practical advantages in identifying radiopaque fragments, fractures, and broad spatial relationships before anatomy is disrupted. Its limitations include metal artefact, incomplete visibility of vascular perforations without appropriate specialised techniques, and the absence of direct tissue sampling. Autopsy offers macroscopic examination, tissue collection, and directed evaluation of wound edges and organ injury, but dissection itself changes anatomy. Combining their findings can make the description of an individual case more complete without replacing crime-scene and ballistic investigation [4,5,10].

This is a single case and cannot yield generalisable firing-distance rules or establish the posture or intentions of the persons involved. Scene evidence and laboratory examination results were not supplied with the submitted report, and no experimental firing-distance comparison is available in the source. Accordingly, the anatomical course and the extent of fatal injury can be characterised more confidently than firing range, firearm specification, position of the right hand at discharge, or dynamic changes in projectile orientation.

Forensic reports are clearest when they identify whether a statement is a directly documented finding, a supported interpretation, or an unresolved possibility. Table *1* illustrates this distinction without assigning

numerical or categorical evidentiary scores that have not been validated. If the investigating agency subsequently provides firearm-test results or a documented scene reconstruction, those results can be reported separately and used to reassess the relevant interpretations.

Directly documented finding	Limited interpretation supported	Not established by the available evidence
Right parasternal entrance-type wound; no exit	Penetrating thoracic firearm injury with projectile retention	Exact impact angle or the shooter's orientation
Eccentric abrasion collar	Possible nonperpendicular impact	Numerical angle of entry
Punctate lesions described as tattooing on hand, neck, face	Possible exposure to discharge-associated particles	Specific muzzle-to-target distance or a defensive posture
Relative sparing under garment	Possible interception of particulate material by clothing	Garment position or definitive clothing-shadow mechanism
Right-to-left, posterior and inferior internal injury pattern	General anatomical direction of projectile passage	Precisely timed path, ricochet, or yaw/tumbling behaviour
PMCT projectile location and thoracic vertebral injury	Imaging-autopsy correspondence for these findings	Independent PMCT proof of each vascular/soft-tissue injury
Deformed jacketed retained bullet	Projectile recovered for potential laboratory comparison	Specific rifled firearm, calibre, or weapon association

TABLE 1: Classification of observations and permissible interpretations.

The columns describe the scope of the submitted evidence; they do not represent a validated ranking system.

PMCT: post-mortem computed tomography

Conclusions

This fatal firearm injury involved a right anterior chest entry wound, extensive intrathoracic soft-tissue damage, thoracic vertebral injury, and retention of a projectile in the left posterior thoracic wall. PMCT documented the projectile location and skeletal injury before dissection, while autopsy established the vascular and visceral injuries responsible for fatal haemorrhage. The punctate skin findings and clothing distribution are relevant observations but do not establish a specific firing distance or victim posture without additional evidence. The case demonstrates the practical value of correlating PMCT with careful autopsy and, equally, the importance of defining the limits of any reconstruction when ballistic and scene-investigation results are unavailable.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Anand Kumar, Soibam Neha, Arwinder Singh, Akhilesh K. Singh, Shailesh V. Parate

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Drafting of the manuscript: Anand Kumar, Soibam Neha, Arwinder Singh, Akhilesh K. Singh, Shailesh V. Parate

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee, All India Institute of Medical Sciences, Rishikesh

issued approval AIIMS/IEC/26/458. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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