

Literature Review

## Rigor Mortis and Its Management in Dental Autopsy Procedures

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### ABSTRACT

**Introduction:** Forensic Odontology plays a crucial role in forensic investigations, including determining the postmortem interval (PMI). Rigor mortis is one of the early signs of death, often presenting challenges during oral examinations. Dental autopsy is a procedure that can address these challenges, enabling a thorough examination of the teeth even in the presence of rigor mortis.

**Review:** Rigor mortis represents a major obstacle in dental autopsy procedures. Muscle stiffness hampers mouth opening and access to the oral cavity. Various techniques can be employed to perform dental autopsies in cases of rigor mortis, such as the use of mouth gags, trismus screws, and myotomy. Jaw resection techniques may also be employed to provide better access to dental structures.

**Conclusion:** Rigor mortis significantly limits oral cavity access during dental autopsy procedures. Characterized by muscle stiffness, presenting a challenge during dental autopsy examination of the oral cavity.

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## INTRODUCTION

Forensic odontology is a rapidly expanding and essential subdiscipline within forensic science. It involves the study of dental structures to assist in personal identification and criminal investigation, using both comparative and reconstructive methods.<sup>1</sup> The field encompasses diverse procedures such as examination of dental records from both before and after death, dental profiling, analysis of bite marks, lip print patterns (cheiloscopy), palatal rugae (rugoscopy), DNA analysis from teeth, facial reconstruction, and image superimposition.<sup>1,2</sup> In legally investigated deaths, postmortem dental examinations serve as a fundamental tool to collect information that can later be matched with antemortem data of the deceased. A major challenge in this process is limited access to the oral cavity, often due to the presence of rigor mortis, or postmortem stiffening of muscles.<sup>3</sup>

A key component of medicolegal postmortem assessment is the estimation of the Post Mortem Interval (PMI), also referred to as Time Since Death (TSD), which plays a crucial role in forensic casework, particularly in unexplained deaths or suspected homicides, including those occurring in medical facilities.<sup>2</sup> PMI refers to the interval between death and body discovery or examination. After death, the body undergoes physical and biochemical changes.<sup>2</sup> These changes result from metabolic cessation, autolysis, and chemical degradation.<sup>2</sup> Several observable signs can aid in estimating the time of death, including algor mortis (body cooling), rigor mortis (muscle stiffness), electrical responsiveness of muscles, analysis of stomach contents, and changes in ocular structures such as the retina and iris.<sup>2</sup>

The early postmortem period, approximately 3 to 72 hours following death, is particularly

important for PMI estimation, as it often aligns with the timeframe when forensic examinations take place. This window allows investigators to construct a timeline and gain insight into the circumstances of death.<sup>4</sup> During this stage, estimations are primarily based on changes in body temperature, muscle rigidity, and postmortem lividity (livor mortis). Algor mortis involves the gradual decrease in body temperature after metabolic functions cease. Rigor mortis refers to muscle stiffening that typically begins a few hours postmortem and can persist up to 30 hours. Livor mortis is observed as a purplish discoloration on lower areas of the body due to blood pooling under gravitational influence.<sup>4,5</sup> Dental autopsies may be conducted either before the development of jaw stiffness or during rigor mortis, using special techniques to facilitate oral cavity access.<sup>3</sup> These procedures involve careful external examination of oral tissues to detect trauma, fluid presence, or foreign materials.<sup>5</sup> This paper explores the role of rigor mortis in forensic dentistry and describes appropriate procedures for conducting dental autopsies under such conditions.

## REVIEW

Determining the PMI (Post Mortem Interval) is a crucial objective of postmortem examinations, as it helps establish the connection between a suspect and the time of death. This estimation supports forensic investigations by identifying the likely timeframe of death, which may narrow down the pool of potential suspects at the time the crime occurred. Additionally, PMI plays a critical role in narrowing the search for unidentified individuals by matching the timeframe of death to those reported missing during that period.<sup>1</sup> The Post Mortem Interval (PMI) is generally divided into three categories: immediate, early, and late stages.<sup>4</sup>

In the immediate phase following death, changes in the body occur primarily due to the cessation of circulation. While this stage signifies somatic death, cellular breakdown and biochemical alterations are not yet apparent. The early postmortem phase, spanning approximately 3 to 72 hours after death, is particularly vital for estimating PMI, as it aligns with the timeframe in which most forensic cases are assessed. It is especially useful for constructing timelines and investigating the circumstances surrounding death. During this period, PMI estimation relies heavily on three primary physiological changes: algor mortis, rigor mortis, and livor mortis.<sup>3,4,6</sup>

### **Algor mortis**

Algor mortis refers to the decline in body temperature postmortem, primarily caused by the breakdown of thermoregulation in the hypothalamus and heat loss through conduction, convection, and radiation.<sup>3</sup> Algor mortis is often considered a useful indicator for determining the Time Since Death (TSD) during the early stage. However, this method involves complex procedures and requires extensive knowledge and research before it can be accurately applied in the field. This complexity is due to multiple influencing factors. These include environmental temperature and body characteristics that influence the temperature gradient between body temperature and the surrounding environment, the most significant being the temperature differences at various locations over time.<sup>3</sup> Individual size is also a major factor; smaller individuals will cool more rapidly than larger ones under the same conditions. Body heat dissipation is modulated by multiple external variables, including solar radiation, garments worn, and other contributing factors.<sup>5</sup> For these estimations, liver

temperature is the preferred metric, but rectal temperature is also considered a viable option.<sup>4,6</sup>

### **Rigor mortis**

Rigor mortis is postmortem muscle stiffening, resulting from a decline in adenosine triphosphate (ATP) levels. This prevents the detachment of actin-myosin filaments, leading to muscular rigidity.<sup>3,5</sup> As ATP breaks down into ADP and lactic acid accumulates, a drop in intracellular pH triggers chemical bonds between actin and myosin filaments. This process begins soon after death and follows a predictable pattern referred to as Nysten's Law or the "march of rigor." Typically, rigor mortis begins within 2 to 6 hours postmortem and peaks by 12 hours.<sup>6</sup>

The stiffness starts with the facial muscles and gradually spreads to the limbs. Rigor mortis typically lasts for 12 to 24 hours before resolving, though it can persist for up to 36 hours, depending on the body and environmental conditions. In general, the rigidity can last anywhere from 24 to 84 hours before the body returns to a flaccid state.<sup>4,6</sup>

The onset and duration of rigor mortis are primarily influenced by two key variables: ambient temperature and the body's metabolic condition. Lower environmental temperatures typically lead to a faster development of muscle rigidity and extend its duration, whereas warmer conditions delay its onset and shorten the stiffening period. Physical exertion shortly before death can also hasten the appearance of rigor mortis. Furthermore, an individual's body mass and the speed of postmortem cooling play significant roles in determining how soon and how long the stiffness will last.<sup>6</sup>

During the terminal stage of rigor mortis, the previously formed actin-myosin cross-bridges begin to disintegrate through proteolytic activity,

resulting in the gradual return of muscular flaccidity. Although this biochemical process occurs concurrently throughout the body, it typically becomes apparent first in the small muscles of the face, then progresses to the upper limbs, and ultimately affects the larger muscles of the lower extremities.<sup>4</sup>

### **Livor mortis**

Livor mortis is among the earliest postmortem changes, characterized by a bluish-purple discoloration appearing in the body's dependent regions due to gravitational pooling of blood within superficial vessels. This process is alternatively referred to as lividity, cadaveric lividity, postmortem hypostasis, or simply hypostasis.<sup>4,6</sup>

It represents a physiological phenomenon. In living individuals, the heart actively pumps blood throughout the body. However, following death, the cessation of circulation allows blood to passively accumulate in the lowest regions due to gravitational forces, resulting in visible discoloration in these dependent areas.<sup>6</sup>

Although the process initiates almost immediately after death, its early signs usually become noticeable around one hour postmortem, with maximum manifestation occurring within 3 to 4 hours. During this phase, blood remains in a fluid state, meaning applied pressure on the skin can temporarily shift the coloration, which returns once the pressure is removed.<sup>4</sup> This blanching effect is typically observed for up to 9 to 12 hours, after which the lividity pattern becomes permanent or "fixed"<sup>4,6</sup> Regions under continuous compression, such as from clothing or body position, often do not exhibit this discoloration.<sup>6</sup>

A dental autopsy encompasses both external and internal examinations of the oral region. The extraoral evaluation focuses on identifying facial

asymmetry, lacerations, pathological conditions, and any alterations in the coloration of the lips or skin. The internal (intraoral) assessment involves the inspection of both hard and soft oral tissues. Examination of the hard tissues requires completion of an odontogram to document the presence of restorations, implants, dentures, artificial materials, or any dental fractures. In contrast, soft tissue evaluation includes the detection of hematomas, lacerations, congenital anomalies, pathological lesions, or other abnormalities within the oral mucosa.<sup>7</sup>

A dental autopsy entails a thorough examination of the mouth's external structures to detect trauma, foamy substances, or any foreign objects. Internal evaluation of the oral cavity requires specific dissection techniques to fully expose the internal anatomy. Two principal methods are commonly used to access dental components: the incision method and the jaw resection method. The incision approach involves strategically cutting and lifting the overlying skin, muscle, and fascia to reveal the dentition while preserving the anatomical relationship between the upper and lower jaws.<sup>8</sup> In contrast, the resection method consists of surgically detaching the maxilla and mandible as separate units.<sup>9</sup> When rigor mortis is present, specialized surgical interventions are needed to improve visibility during intraoral inspection. Tools such as mouth gags, trismus screws, and intraoral myotomy are often employed, sometimes in combination with extraoral dissection of the facial or submandibular areas.<sup>6,7</sup> To better access the vestibular and buccal aspects of the teeth, a V-shaped incision may be made externally, extending from the corners of the mouth toward the ear region.<sup>10</sup>

In cases where the body remains visually recognizable, an infra-mandibular incision is utilized to maintain facial appearance. This surgical cut

extends from the mandibular angle to the midline of the chin, tracing along the lower edge of the mandible. The approach enables upward reflection of soft tissues and facilitates separation of the masseter muscle and vestibular attachments from the underlying bone. When rigor mortis is present, traction devices may be required to adequately open the oral cavity.<sup>10,11</sup>

In infant cadavers, rigor mortis tends to be less pronounced than in adults, making intraoral access generally more manageable. Consequently, a technique involving a curved incision along the alveolar crest of both the maxilla and mandible is recommended. This is followed by periosteal elevation and the removal of developing dental structures using elevators. Extracted tooth buds and unerupted teeth are promptly preserved in solutions such as 10% formalin, 1% phenol, or 10% sodium hypochlorite, facilitating later assessment of dental development stages. Meanwhile, all erupted teeth are documented through an odontogram.<sup>7,12</sup>

Despite its usefulness, the incision approach is limited by anatomical constraints, which can restrict full access to the dentition, particularly in the presence of rigor mortis. Therefore, jaw resection techniques are often employed to allow comprehensive evaluation while minimizing structural damage.<sup>10,13</sup>

#### **Stryker Stryker Saw Method**

This method involves dissecting the soft tissues and muscular attachments along the lateral aspect of the mandible. An incision is made through the mucobuccal fold down to the mandible's lower edge, including detachment of the masseter. On the lingual side, the pterygoid attachment is also severed. Once all muscle attachments are released, the mandible is sectioned using a Stryker saw, typically at a high point on the ramus to preserve impacted

third molars. For maxillary access, the bone is cut near the zygomatic process, just above the anterior nasal spine, allowing removal of the maxilla while retaining apical portions of the teeth.<sup>5,14</sup>

#### **Mallet and Chisel Method**

In this manual approach, bilateral incisions are made along the buccal vestibule after opening the lips. All soft tissue attachments are dissected high along the zygomatic arch and anterior nasal spine. A controlled fracture is then induced from the nasal septum laterally to the pyriform aperture, extending above the tooth roots and beneath the zygomatic-maxillary junction to the pterygomaxillary junction and pterygoid plate. This results in a Le Fort I-type separation of the maxilla with the attached dentition.<sup>5,14</sup> Since this technique does not allow for mandibular ramus separation, the mandible must be isolated by dissecting all soft tissues as done in the Stryker method, then detached at the temporomandibular joint.<sup>5,14</sup>

#### **Archimedes' Screw Method**

Ideal for cases with restricted mouth opening due to rigor mortis, this non-invasive method requires no incisions or full resection. The tool comprises two screws joined by a central rotator. Each screw is drilled into the alveolar ridge between the first and second premolars on either side. As the central screw is turned, the two screws move apart, gradually separating the jaws. In some cases, the condylar head may even detach from the glenoid fossa. Although visibility is somewhat limited, the facial structure remains intact, making it advantageous for subsequent facial reconstruction procedures.<sup>5,14</sup>

Utilizing the appropriate method in cadavers affected by rigor mortis ensures adequate access to

the oral cavity during autopsy while aligning with current ethical principles focused on facial preservation. This approach acknowledges the sensitivities of surviving relatives and enhances the dignity of the forensic process. Moreover, it supports both the technical efficacy of oral examinations and public trust in medicolegal practices.<sup>15</sup>

## CONCLUSION

Rigor mortis, a postmortem phenomenon characterized by muscle rigidity, often complicates access to the oral cavity during dental autopsies. To address this, various techniques may be employed, including extraoral incisions, inframandibular approaches, and jaw resection methods utilizing instruments such as the Stryker saw, mallet and chisel, or the Archimedes screw device.

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