

Revisiting autopsies of death by mechanical asphyxia in the search for post-mortem pink teeth

Alyssa Niara Brites¹,
Ana Luísa Rezende Machado^{1,2},
Ademir Franco³,
Ricardo Henrique Alves Silva⁴

¹Forensic Odontology Specialization Program, School of Dentistry of Ribeirão Preto, University of São Paulo, São Paulo, Brazil.

²Department of Pathology and Legal Medicine (MSc Candidate), Ribeirão Preto Medical School, University of São Paulo, São Paulo, Brazil.

³Department of Therapeutic Stomatology, Institute of Dentistry, Sechenov University, Moscow, Russia.

⁴Chair, Forensic Odontology, School of Dentistry of Ribeirão Preto, University of São Paulo, São Paulo, Brazil.

Corresponding author:
ricardohenrique@usp.br

The authors declare that they have no conflict of interest.

KEYWORDS

Asphyxia,
Autopsy,
Forensic Dentistry,
Pink tooth

J Forensic Odontostomatol
2020. May;(38): 1-34:38
ISSN :2219-6749

ABSTRACT

Background: In contemporary forensic practice, Medicine and Dentistry combine forces to improve the search for the cause of death and human identification. The pink tooth phenomenon (PTP) is a cadaveric sign that allegedly manifests more often in victims of asphyxia. However, the scientific literature is scarce and controversial on this aspect. **Objective:** This study aimed at screening victims of mechanical asphyxia in order to search for post-mortem pink teeth. **Material and methods:** Retrospectively, autopsy reports from a local medico-legal institute in South Brazil were revisited in the search for victims of death by asphyxia. Autopsy reports of twenty one victims aged between 6 and 67 years (mean age: 40.6 years $\pm$ 19.20; median: 37 years) were found and analyzed. **Results:** The different modalities of asphyxia included drowning (n=7; 33.33%), strangulation (n=1; 4.76%) and hanging (n=13; 61.91%). A single case of PTP was detected (4.76%) – a 26-year-old male victim of hanging. **Conclusion:** This study illustrates and highlights the unspecific aspect of the PTP. In practice, forensic experts must avoid interpretations of this phenomenon as conclusive evidence of the cause of death, such as asphyxia by drowning, strangulation or hanging.

INTRODUCTION

Violent deaths, such as homicides, suicides and accidents, figure amongst the reasons that more commonly justify medical or dental autopsies.¹ During the autopsy, the search for the cause of death plays an important role in forensic investigations.² From a scientific point of view, the study of death and its inherent signs is named thanatognosis – a field within thanatology.³ Several death signs of medical interest may be retrieved from deceased bodies to support inferences about the cause of death.⁴ Profuse froth from the nostrils, broken horns of the thyroid cartilage and sloped suspension peak marks are examples of cadaveric signs that may be found in victims of asphyxia by drowning, manual strangulation and suicidal hanging, respectively.⁵

While on one hand, several cadaveric signs may be detected by pathologists during the medical autopsy, a restricted number of signs are available and useful when it comes to the participation of Forensic Dentistry in the search for the cause of death.⁶ The pink tooth phenomenon (PTP) represents a cadaveric sign eventually detectable in dental autopsies.⁷⁻⁹ Throughout the years, the PTP was more commonly reported in cases of violent deaths by asphyxia, such as drowning.¹⁰

However, over time, the PTP was gradually denoted as a unspecific cadaveric sign that may manifest more evidently in deceased bodies retrieved from moist environments.¹

The biomechanics behind the PTP also may involve the differences in pressure and their influence on pulp tissue. Under these circumstances, dentine might be stained by the haemoglobin from pulp red cells.¹¹ It is important to note that staining occurs in the dentinal tubules. These are distinctive structures formed during the dentinogenesis process.^{12,13} From a biological perspective, the dentinal tubules enable hydration and sensory responses.¹⁴ In relation to PTP, it is well known that the diameter of red cells prevents their entrance in the tubules, however, it must be noted that the size of tubules might be different between populations.¹⁴ From a macroscopic view, stained teeth show the typical colour range from pink to brownish. In older victims, on the other hand, the colour might be discrete because the pulp tissue is less abundant as secondary dentine progressively grows, reducing the size of the pulp chamber.¹⁵

The controversial meaning and uncertainty behind the PTP justify more studies in the field. With the increase of scientific literature, stronger evidence may be used to support the interpretation of the PTP in the forensic routine. Based on the hypothesis that PTP is not an indicator of the cause of death (in this case, specifically for mechanical asphyxia), this study aimed to screen dental autopsies of violent deaths by mechanical asphyxia in order to search for the incidence of PTP.

MATERIAL AND METHODS

Ethical aspects and study design

This study was approved by a local medico-legal unit in South Brazil and received institution ethical clearance from the Committee of Ethics in Research (protocol: 63504916.6.0000.5419). A descriptive survey was designed and carried out.

Sampling and eligibility

The sample consisted of medical and dental autopsy reports retrospectively assessed from a local mortuary in South Brazil. Based on the inclusion criteria, only medical or dental autopsy reports of victims of violent deaths by mechanical asphyxia were considered. According to the exclusion criteria, reports with missing

information of dental status were not eligible, as well as reports with missing information about the type of mechanical asphyxia.

Variables and examiners

Within screened autopsy reports, the search variables were: I) the type of mechanical asphyxia, II) the sex and III) the age of the victim, IV) the aspect of the victim's face, V) the presence of pink teeth, VI) the type of material used for neck constriction, VII) the position of the knot, VIII) the position of the body and IX) the time between death and cadaveric examination. Variables VI, VII and VIII were applicable only in cases of strangulation or hanging. The search was performed by a main examiner – a forensic odontologist with two years of experience in the field, under the supervision of a second forensic odontologist with ten years of experience. The collected data were recorded in structured spreadsheets and descriptively analyzed.

RESULTS

A descriptive overview of the cadaveric findings is provided in Table 1. Twenty one cases of violent death by mechanical asphyxia were detected. The victims consisted of three females and 18 males aged between 6 and 67 years (mean age: 40.6 years $\pm$ 19.20; median: 37 years). Within the modalities of mechanical asphyxia, drowning (n=3 females and 4 males) was found in 33.33% of the cases, strangulation (n=1 male) in 4.76% and hanging (n=13 males) in 61.91%.

In 13 cases (61.91%), the victim's face was cyanotic, while in seven cases (33.33%) the face was pale. In one case (4.76%) the analysis of the victim's face was not feasible because of advanced decomposition. The PTP was found only in a single case (4.76%) – a 26-year-old male victim of hanging.

The type of material used for neck constriction, the position of the knot and the position of the body were reported only for cases of hanging (n=13). Soft constriction material was used in 10 hanging cases (76.92%), while in two cases (15.38%) semi-rigid material was used. Hard constriction material was used in a single case (7.7%). The hanging knot was positioned on the lateral surface of the neck in seven cases (53.84%) and on the posterior surface in six cases (46.16%). In most of the hanging cases (53.84%), the position of the suspended body was not reported. Autopsy reports that provided this information

indicated complete and partial body suspension in 5 (38.46%) and 1 (7.7%) hanging cases, respectively.

The time between death and autopsy was

reported only in cases of drowning (n=7). Four (57.14%) of these cases reported a time since death longer than 24 hours, while 3 cases (42.86%) reported an interval less than 24 hours.

Table 1. Case-specific characteristics of the victims of mechanical asphyxia

Asphyxia	#	Age	Face	PTP	Material	Knot	Position	Time
Drowning	1	37	Cyanotic	No	-	-	-	<24h
	2	29	Cyanotic	No	-	-	-	>24h
	3	11	Pale	No	-	-	-	>24h
	4	26	-	No	-	-	-	>24h
	5	34	Cyanotic	No	-	-	-	<24h
	6	34	Pale	No	-	-	-	<24h
	7	19	Cyanotic	No	-	-	-	>24h
Strangulation	8	6	Cyanotic	No	-	-	-	-
Hanging	9	52	Cyanotic	No	Rigid	Posterior	-	-
	10	57	Pale	No	Semi-rigid	Lateral	-	-
	11	60	Cyanotic	No	Soft	Posterior	Complete	-
	12	54	Cyanotic	No	Soft	Lateral	Complete	-
	13	56	Cyanotic	No	Soft	Posterior	Complete	-
	14	67	Pale	No	Soft	Posterior	Partial	-
	15	19	Pale	No	Semi-rigid	Posterior	-	-
	16	53	Pale	No	Soft	Lateral	-	-
	17	26	Cyanotic	Yes	Soft	Lateral	Complete	-
	18	73	Cyanotic	No	Soft	Lateral	-	-
	19	64	Pale	No	Soft	Lateral	-	-
	20	44	Cyanotic	No	Soft	Lateral	Complete	-
	21	33	Cyanotic	No	Soft	Posterior	-	-

#: number given to each cadaver for didactic purposes; PTP: Pink tooth phenomenon; -: information not applicable or not available; times correspond to the time from death to autopsy; position indicates if the body was completely or partially suspended after hanging.

DISCUSSION

Over the last 190 years, the PTP was reported and studied in the routine of Forensic Medicine and Dentistry.¹⁶⁻²⁵ Originally, in 1829, Bell⁷ described the PTP in victims of mechanical

asphyxia – more specifically in cases of drowning and strangulation. Sequentially, other studies also reported the PTP within victims of the same cause of death.^{10,22,23} Because of the recurrent

manifestation of the PTP in cases of mechanical asphyxia, less experienced forensic experts began to (mis)interpret the former as a pathognomonic sign of the latter. Consequently, the recent scientific literature strives to clarify this scenario by pointing out the PTP as a cadaveric finding unspecific for the cause of death.¹ This study aims to revisit dental autopsy reports of victims of mechanical asphyxia in order to demonstrate that the PTP is not necessarily a cadaveric marker of the cause of death.

Out of the autopsy reports of the twenty one victims sampled in this study, initial information about sex and age were retrieved. The ratio between males and females was 1:6, respectively. The higher number of males is justified by the fact that, globally, men are more involved in violent deaths than women²⁶ and violent deaths explain the need for autopsies.¹ In relation to age, the scientific literature shows that the PTP may be more common in young victims because the dentinal tubules reduces in size in adults²⁷ and because the volume of the pulp chamber decreases with the continuous deposition of secondary dentine throughout life. As a result, less blood is available in the pulp to promote the reddish colouration.

The rationale behind the PTP is explained in different ways by the scientific literature. While on one hand, the opinion that the colouration that characterizes the PTP results from the haemoglobin that penetrates the dentinal tubules is indisputable,²⁰ on the other hand, the mechanism that induces the extravasation of blood cell components to the dentine is uncertain. Increase in blood pressure, rupture of blood vessels and consequent haemorrhage in the pulp chamber figure among the explanations.²⁶ Explanations for the increased blood pressure relies on the peri-mortem blood congestion in the head and eventually in the pulp chamber.²⁷ However, due to the scarce experimental studies in the field and the ethical limitations of working with animal models,¹ certainty of haemorrhage in the pulp chamber after asphyxia may not be guaranteed.²⁵

In particular, the controversial contribution of blood congestion in the head to trigger the PTP becomes even more uncertain when it comes to the fact that several cases of strangulation and hanging do not lead to post-mortem tooth colouration.²² The autopsy reports revisited in the present study corroborate this scenario by

showing a single victim with PTP (victim of hanging) compared to the other thirteen victims of mechanical asphyxia by strangulation or hanging that did not present with PTP. The same counts for drowning, especially because blood congestion in the head is not necessarily a thanatological sign of this modality of mechanical asphyxia.²² In this study, all the victims of death by drowning did not present post-mortem pink teeth. According to the scientific literature, cases of drowning that show the PTP may be justified by the position of the head of the drowned cadaver (downwards), which allows blood flow towards the head.²²

Other contributing factors to be considered in the occurrence of the PTP are the decomposition process and the moist and wet environments. The former plays an important role breaking erythrocytes to produce the colouration of teeth.¹⁷ This process is evidently relevant considering that the average diameter of the erythrocyte (7.5µm) itself is larger than the average diameter of the dentinal tubules (3µm).¹⁶ After the microscopic pathway through haemolysis, blood cell components, especially haemoglobin, are available to penetrate the dentine and culminate in the macroscopic coloured aspect of the PTP. Moist and wet environments not only accelerate the process of decomposition, but also maintain the solubility of tooth tissues enabling the diffusion of blood products from the pulp chamber to the dentine.¹⁷ It is important to note that the PTP is detected during the cadaveric examination of the oral cavity. Hence, the present study highlights the importance of dental autopsies as an adjuvant to medical autopsies. Trained professionals, namely forensic odontologists, must be consulted for specialized forensic expertise in the oral cavity. Using knowledge from clinical and Forensic Dentistry, these experts may not only detect post-mortem pink coloured teeth, but also distinguish it from ante-mortem coloured teeth (e.g. from dental trauma).

Future studies in the field should focus on establishing experimental set ups with animal or human models following proper ethical standards. Body farms emerge as alternatives to be explored in the context of the PTP. Among the advantages of these alternatives is the possibility of testing the exact influence of decomposition and environment over the PTP in a controlled scenario.²⁸

CONCLUSIONS

The dental autopsy cases revisited and analyzed in this study confirmed the PTP as

an unspecific thanatological sign in the cause of death. In particular, the PTP was detected in a single case out of the twenty one victims of violent death by mechanical asphyxia, namely drowning, strangulation and hanging.

REFERENCES

1. Franco A, Mendes SDSC, Picoli FF, Rodrigues LG, Silva RF. *Forensic thanatology and the pink tooth phenomenon: From the lack of relation with the cause of death to a potential evidence of cadaveric decomposition in dental autopsies - Case series.* *Forensic Sci Int* 2018;291:e8-12.
2. Banwari M. *An erroneous opinion on a cause of death in a forensic autopsy: a case report.* *Afr Health Sci* 2017;17:1246-9.
3. Aggrawal A. *Textbook of forensic medicine and toxicology.* 1st ed. Delhi, India. Avichal Publishing Company; 2014.
4. Saukko P, Knight B. *Knight's forensic pathology.* 3rd ed. London, UK. Hodder Arnold; 2004.
5. Shepherd R. *Simpson's forensic medicine.* 12th ed. Boca Raton, USA. CRC Press; 2003.
6. Heit O, Silva RF, Franco A. *Improving traditional dental autopsies in postmortem examinations of intraoral gunshot wounds.* *J Forensic Leg Med* 2014;23:87-90.
7. Bell T. *Anatomy, physiology and diseases of the teeth.* 1st ed. London, UK. Stewart and Company; 1829.
8. Borrmann H, Du Chesne A, Brinkmann B. *Medico-legal aspects of postmortem pink teeth.* *Int J Leg Med* 1994;106:225-31.
9. Sakuma A, Saitoh H, Ishii N, Iwase H. *The effects of racemization rate for age estimation of pink teeth.* *J Forensic Sci* 2015;60:450-2.
10. Campobasso CP, Di Vella G, De Donno A, Santoro V, Favia G, Introna F. *Pink teeth in a series of bodies recovered from a single shipwreck.* *Am J Forensic Med Pathol* 2006;27:313-6.
11. De Almeida CA, Daruge E, Daruge E Jr, El-Guindy M. *Comparative study of experimentally induced and post-mortem pink teeth.* *J Forensic Odontostomatol* 1996;14:25-7.
12. Niño-Barrera JL, Gutiérrez ML, Garzón-Alvarado DA. *A theoretical model of dentinogenesis: dentin and dentinal tubule formation.* *Comput Methods Programs Biomed* 2013;112:219-27.
13. Caruso S, Bernardi S, Pasini M, Giuca MR, Docimo R, Continenza MA, Gatto R. *The process of mineralisation in the development of human tooth.* *Eur J Paediatr Dent* 2016;17:322-6.
14. Arola DD, Gao S, Zhang H, Masri R. *The tooth: its structure and properties.* *Dent Clin North Am* 2017;61:651-68.
15. Bernardi S, Bianchi S, Fantozzi G, Leuter C, Continenza MAI, Macchiarelli G. *Morphometric study on single-root premolars in a European population sample: an update on lengths and diameters.* *Eur J Anat* 2019;23:17-25.
16. Gowda BKC, Sivapathasundharam B, Chatterji A, Chatterji BL. *Histological appearance of postmortem pink teeth: report of two cases.* *J Forensic Dent Sci* 2015;7:168-70.
17. Kirkham WR, Andrews EE, Snow CC, Grape PM, Lorenza S. *Postmortem pink teeth.* *J Forensic Sci* 1977;22:119-31.
18. Van Wyk CW. *Postmortem pink teeth: in vitro production.* *J Oral Pathol Med* 1988;17:568-72.
19. Sainio P, Syrjänen S, Keijälä JP, Parviainen AP. *Postmortem pink teeth phenomenon: an experimental study and a survey of the literature.* *Proc Finn Dent Soc* 1990;86:29-35.
20. Ortmann C, Du Chesne A. *A partially mummified corpse with pink teeth and pink nails.* *Int J Legal Med* 1998;111:35-37.
21. Dumser TK, Türkay M. *Postmortem changes in human bodies on the Bathyal sea floor – two cases of aircraft accidents above the open sea.* *J Forensic Sci* 2008;53:1049-52.
22. Brondum N, Simonsen J. *Postmortem red coloration of teeth.* *Am J Forensic Med Pathol* 1987;8:127-30.
23. Soriano EP, De Carvalho MVD, Dos Santos FB, Mendoza CC, De Araújo MSD, Campello RIC. *The post-mortem Pink teeth phenomenon: a case report.* *Med Oral Patol Oral Cir Bucal* 2009;14:337-9.
24. Beeley JA, Harvey W. *Pink teeth appearing as a post-mortem phenomenon.* *J Forensic Sci Soc* 1973;13:297-305.
25. Clark DH, Law M. *Post-mortem pink teeth.* *Med Sci Law* 1984;24:130-4.
26. Reza A, Mercy JA, Krug E. *Epidemiology of violent deaths in the world.* *Injury Prev* 2001;7:104-11.
27. Camps F. *Medical and scientific investigations in the Christie cases.* 1st ed. 21. Montenegro JB, Queiroz EGAL, Moreno BLG, De Souza EHA, De Carvalho MVD, Soriano E. *Dentes Rosado observados quatro meses após a morte.* *Derecho Cambio Social* 2013;1:1-7.
28. Wallman JF. *Body farms.* *Forensic Sci Med Pathol* 2017;13:487-9.