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Postmortem Pink Teeth

The observation, in 1953, of pink-colored teeth in the exhumed body of a victim in the Christie murders appears to have been the first report of this postmortem phenomenon in recent times [*1*]. In reporting this and four other cases, Miles and Fearnhead [*2*] suggested that the pinkness is a natural postmortem phenomenon caused by the seepage into the dentinal tubules of a fluid containing hemoglobin or its degradation products derived from decomposition or liquefaction of the tooth pulp. Beeley and Harvey [*3*] further reviewed the occurrence of this phenomenon and recorded additional cases in five humans and one dog. Their studies on the red gelatinous material in the pulp chambers of pink teeth gave spectrophotometric evidence for the presence of hemoglobin or other heme compounds. Isoelectric focusing confirmed the identification of the material as hemoglobin or derivatives of hemoglobin.

Our interest in this postmortem finding was stimulated by a few pink teeth in the skeletal remains of a child found about 2 months after death. Since then we have examined pink teeth from a number of bodies. The gross and laboratory observations on these teeth further understanding of this phenomenon.

Cases

Case 1

An 11-year-old white female in an advanced state of decomposition, enclosed in plastic garbage bags, was found in late spring 3 weeks after she was reported missing. The crowns of the teeth were distinctly pink, the color being greater in the anterior teeth than in the molars, and the pink of the roots was more red than that of the crowns. No red discoloration was noted in the bony sockets.

Case 2

A 39-year-old white male was shot in the head and left in a well house. When discovered, the body was decomposed. All teeth were decidedly pink, and the color was

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greatest in the incisors, canines, and premolars. The roots were a deeper red. The crowns of the molars were not pink, but the roots were red.

Case 3

The body of a 31-year-old Mexican male with weights attached rose to the surface of a lake in midsummer. Approximately 4 days had elapsed since he was killed. The crowns were only slightly pink but the roots were light pink.

Case 4

The body of a 23-year-old Mexican male with a bullet hole in the head was found in a shallow grave in January. An advanced state of decomposition was evident. The skull, with teeth, was studied for identification. Nine months later some of the teeth had a pink-brown color.

Case 5

A 44-year-old white male died in an automobile fire. The front teeth were charred, but 24 h after death the roots of some of the molars were slightly pink.

Case 6

The body of a 43-year-old male, found in an advanced state of decomposition in July, revealed no upper teeth, six lower anterior teeth, a few molars, and a lower removable partial denture. A distinct red color was visible through the enamel of the crowns in all teeth except one carious canine, which was white.

Case 7

Included in a forensic collection was the skull of a 40-year-old Negro male. He had died from an overdose of barbiturates, and his body had remained undiscovered for 4 months. Four years later, during the present study, several of the teeth were noted to have a gray-black discoloration of the crowns and roots.

Case 8

The original case that prompted our interest was the skeletal remains of a 4½-year-old Caucasian child, a twin and one of three children whose remains were found at ground surface about 3 months after death. Two anterior teeth were pink; other teeth were normal, as were teeth in the remains of the other twin and another child.

Case 9

The body of a 23-year-old Indian male was found in mid-August, 2 months after death. The body was almost skeletonized. The skull, with teeth in place, was studied for identification. Twelve months later, as a result of interest in the pink tooth phenomenon, the teeth were studied in more detail because of a brown color of a few anterior teeth.

Case 10

A 46-year-old man killed himself by firing a shotgun into his mouth. His body was

discovered out of doors in November after 12 days of rainy weather. The lower and few remaining upper teeth had pink crowns and roots.

Observations

Case 1 was an outstanding example of postmortem pink coloration of teeth in a child. Viewed through the enamel of the crowns, the teeth were definitely pink and the roots were decidedly red. Several teeth were fractured in a brass cylinder by a blow to a close-fitting pestle. The pulp chambers were large and filled with wet, red gelatinous material (Fig. 1). The fractured surface of the dentin had a large zone of red color diminishing

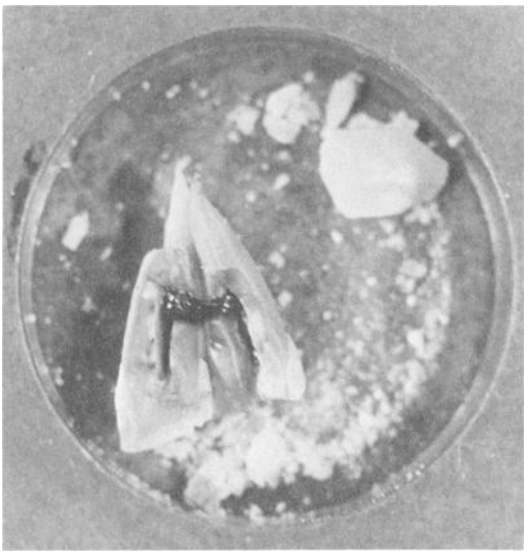

FIG. 1—*Fractured tooth from Case 1 showing wet, red gelatinous pulp tissue and red discoloration of the dentin caused by the presence of hemoglobin.*

peripherally near the cementum or enamel. The red gelatinous material was removed from the pulp chamber with forceps and agitated in 0.14*M* saline solution. One saw, microscopically, amorphous debris, degenerative tissue clumps, and bacteria but no intact erythrocytes or tissue cells. On centrifugation the red color remained in the supernatant fluid, a further indication that the erythrocytes were hemolyzed.

We cleaned the teeth externally by scraping them with a scalpel and scrubbing them several times with a brush and detergent. They were then fractured individually in the sterilized brass cylinder. Material was taken from the pulp chambers with sterile loops, put in three drops of saline, and plated onto culture media. Viridans group *Streptoccus,* hemolytic *Escherichia coli,* and Enterobacteriaceae were identified. Anaerobic cultures were negative.

The gelatinous material from the pulp chambers of three teeth was suspended and agitated in 1 ml of 0.14*M* saline and the solution was centrifuged, giving rise to a red supernatant solution. The pulp chambers were then irrigated with saline to remove adhering soft tissue fragments. This resulted in a clear zone in the dentin bordering the pulp chamber; the major portion of the dentin remained red (Fig. 2). Each fractured tooth was placed in 1 ml of 0.14*M* saline and left overnight at 4°C. The solutions became

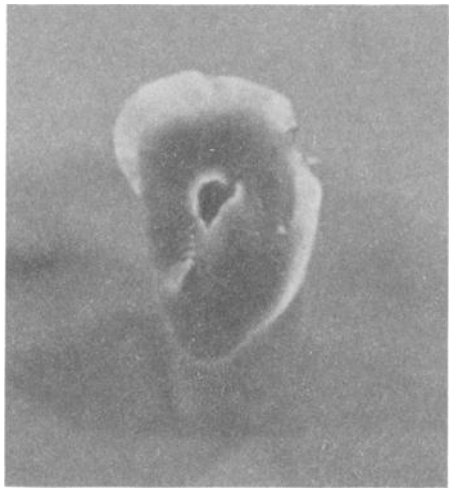

FIG. 2—*Fractured surface of tooth from Case 1 in which the central pulp chamber has been irrigated with saline. A diffuse zone of red coloration, extending from the pulp chamber to the cementum and enamel, remains in the dentin.*

increasingly red while the dentin returned to a white color. A Cary spectrophotometer was used to make absorption curves of each solution of pulp chamber contents and extracts from dentin. As shown in Fig. 3, the solution derived from dentin parallels that obtained from the pulp chamber contents, and both solutions have absorption curves matching that of hemolyzed blood.

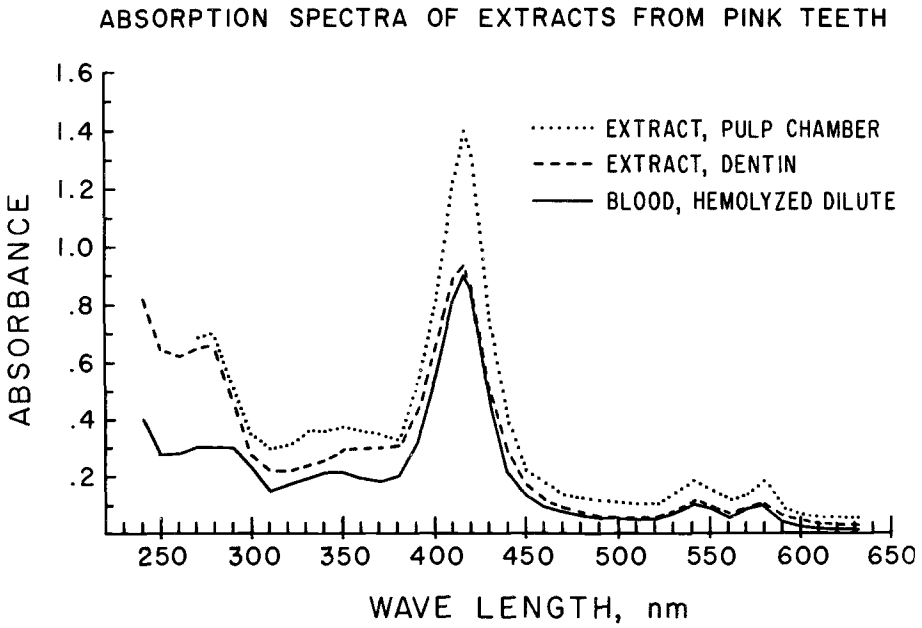

FIG. 3—*Absorption spectra of extracts of pulp tissue and of dentin compared with absorption spectra of hemolyzed whole blood. The maxima near 420, 580, and 540 nm of the extracts correspond closely to those in hemolyzed blood, an indication that the red material in these solutions is a heme compound.*

The extracts of pulp chamber contents and dentin were concentrated by using a dialysis tubing in granular sucrose. The solutions were electrophoresed on cellulose acetate by using a pH 7.4 buffer in a Beckman Microzone apparatus. Hemolyzed whole blood was used as a control. The unstained membranes revealed, in each solution, a major component that migrated as hemoglobin. Ponceau-S staining revealed the presence of albumin and globulins, in addition to hemoglobin, as components of the extract of pulp and dentin (Fig. 4). Thus, the material extracted from the dentin had the protein components of hemolyzed blood.

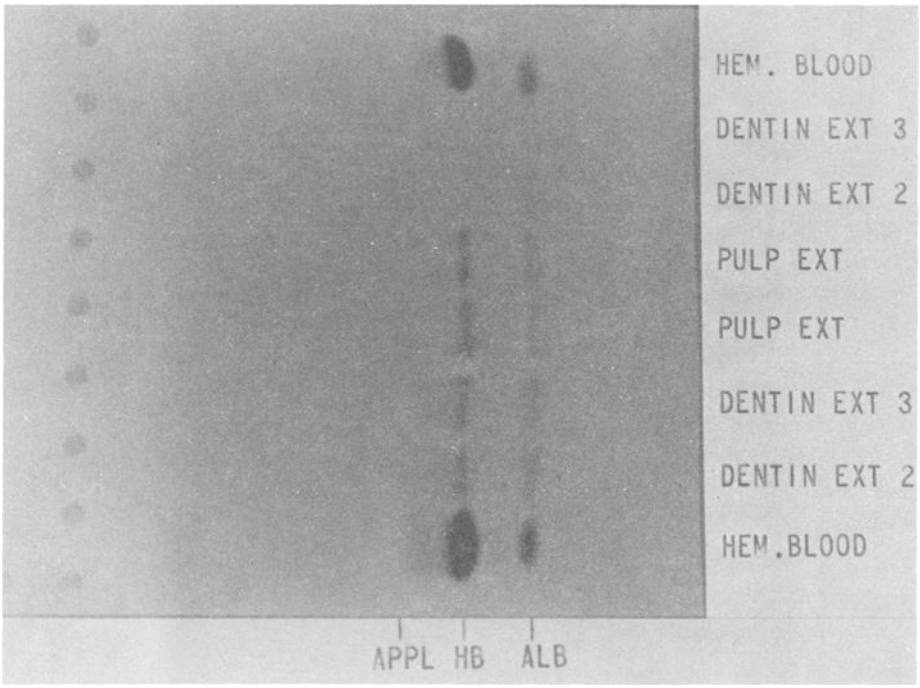

FIG. 4—*Electrophoretic patterns of extracts of dentin and pulp as compared to the proteins of hemolyzed blood. All show a hemoglobin zone* (HB), *an albumin zone* (ALB), *and other serum proteins. The two upper unconcentrated dentin extracts show faint zones. The electrophoretic strip was stained with Ponceau-C.*

Teeth from Case 2, an adult, were fractured longitudinally. The red material in the dentin failed to extract into 0.14*M* saline in 10 or more days. After more extensive fracturing and constant agitation for 48 h, the red material was extracted into water. The solution, after this time, was more yellow than red. Similarly, teeth from Case 4 gave up the red material slowly; by the time the solutions were concentrated and electrophoresed they showed only traces of hemoglobin. Albumin and other serum proteins were demonstrated by electrophoresis to be present in these solutions.

Teeth from Case 3 appeared to have early onset of pink coloration. The maxilla and mandible with teeth in place were enclosed in a clear plastic bag and kept moist at room temperature for several weeks. In 3 days the teeth appeared to have some increase in pinkness, but they never developed the full color seen in other specimens. Instead, the roots developed a slightly brown color.

Case 5 was judged to have some early pink coloration of the roots of molars, probably resulting from the effects of fire. Several fractured teeth had a semidry tissue strand in the root canal and pulp chamber. A slight pink color was seen in the dentin around the

root canal in the proximal portion of the root. Those without detectable pink color of the pulp had no staining of the dentin.

Teeth from Case 6 were those of a mature male whose upper teeth had previously been extracted and who had a partial lower denture with only six remaining lower anterior teeth. All were red as viewed through the crowns except the right lateral incisor, which was white and had a carious lesion on the distal surface of the crown. The pink teeth, when fractured, had yellow-gray material in the pulp chamber and diffuse red color in the dentin. The carious tooth had a dry avascular pulp, and the dentin was white. Case 10 had diffuse pink staining of the dentin and yellow-brown pulp.

The foregoing observations suggested that the hemoglobin accounted for the red color of the dentin and that the amount of hemoglobin was related to the vascularity and fluidity of the pulp chamber contents during the color change.

Production of Pink Coloration Under Controlled Conditions

A dental drill was used to enlarge the root canals of the upper central incisors of Case 1 to admit a 22-gauge needle. By means of needles in place in the pulp chambers, 0.14*M* saline was allowed to flow slowly through the teeth and out the root canals around the needles. Over a weekend of irrigation with 3 litres of saline, the teeth returned to a more normal color (Fig. 5), an indication that the hemoglobin and soluble proteins had been

FIG. 5—*Central upper incisors of Case 1 after irrigation with saline. The protein material imparting the red color to the teeth has been removed by the saline irrigation.*

washed out of the dentin. Then, a syringe and needle was used to fill the pulp chamber of one tooth with whole blood with intact erythrocytes; the other tooth was filled with the same blood, but the erythrocytes had been hemolyzed by freezing. The root canals were plugged with vinyl plastic putty, and the teeth were maintained in a covered beaker containing moist cotton. Within 24 hours the tooth into which the hemolyzed blood had been instilled became pink-red with pink crowns and red roots (Fig. 6). The other tooth remained unchanged. In the ensuing several days, some liquid oozed from the cementum of the pink tooth and the surface of the cementum turned brown. In 10 days the tooth in which intact red cells had been instilled became pink, and at 3 weeks it was pinker than the previously described tooth containing the hemolyzed erythrocytes. Later it oozed a light brown fluid from the surface of the cementum.

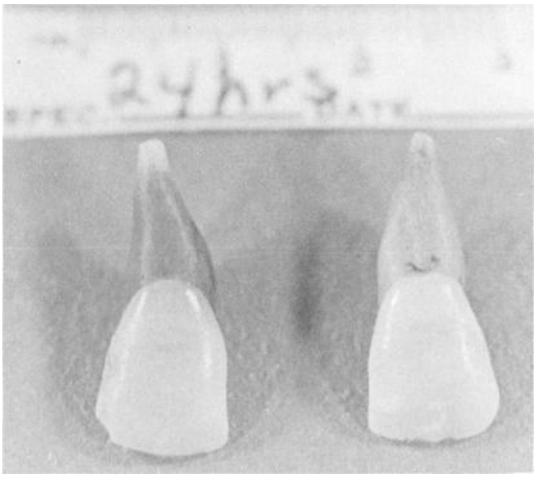

FIG. 6—*The same teeth as in Fig. 5, 24 h after hemolyzed blood has been instilled into the pulp chamber in the tooth on the left and whole (unhemolyzed) blood has been instilled into the tooth on the right. Hemoglobin, free of its red-cell containment, has diffused into the dentin imparting a pink-red color to the tooth on the left. The tooth on the right became pink-red some 10 days later.*

Teeth collected from a dental clinic were drilled to allow the instillation of whole blood and blood hemolyzed by freezing. Those receiving hemolyzed blood developed pink color more readily than did those receiving whole blood, although the pink color was not as striking as noted in the teeth from Case 1. It appeared that hemoglobin from lysed cells more readily diffused into the dentin and accounted for the early development of the pink color; however, when intact red cells were used, a period of time was required for autolysis and hemolysis to take place before the pink color was imparted to the dentin.

Color Changes in Pink Teeth with Time

A tooth from Case 2 was allowed to remain at ambient laboratory temperature and atmospheric conditions. Over a period of 4 months the tooth remained pink-red with a tendency toward slight brown color. It was similar to some of the teeth in Case 4, which had shown the pink-brown color for 1 year.

Each of three teeth from Case 2 was placed in a screw-cap glass tube containing just enough water to wet the walls. The air spaces of the three tubes were changed to 100% O_2, CO, and CO_2, respectively. The tubes were sealed and observed. Teeth in atmospheres of O_2 and CO became gray-brown over a period of 2 weeks, and the color remained gray-brown 6 months later. The tooth in the CO_2 atmosphere retained its red-pink color for more than 6 months.

It appeared that the gray discoloration of teeth, as in Cases 7 and 9, could represent hemoglobin in the dentinal tubules after prolonged aging and drying. Teeth from these cases were transected by using a dental abrasive disc. Diffuse gray zones were present in the dentin, and dry brown pulp remnants were present in the pulp chambers. Such zones of discoloration of the dentin appeared to correspond to those seen in pink teeth.

Histological and Histochemical Studies

Teeth from Case 1 were fixed in formalin for 7 days and then decalcified. On hemotoxylin-eosin staining of sections, small filaments of eosinophilic material could be seen in some of the dentinal tubules. Sections stained for hemoglobin (peroxidase) by Lepehne's

procedure [4] revealed a zone of staining in the dentin (Fig. 7). Stains were negative for hemosiderin and iron.

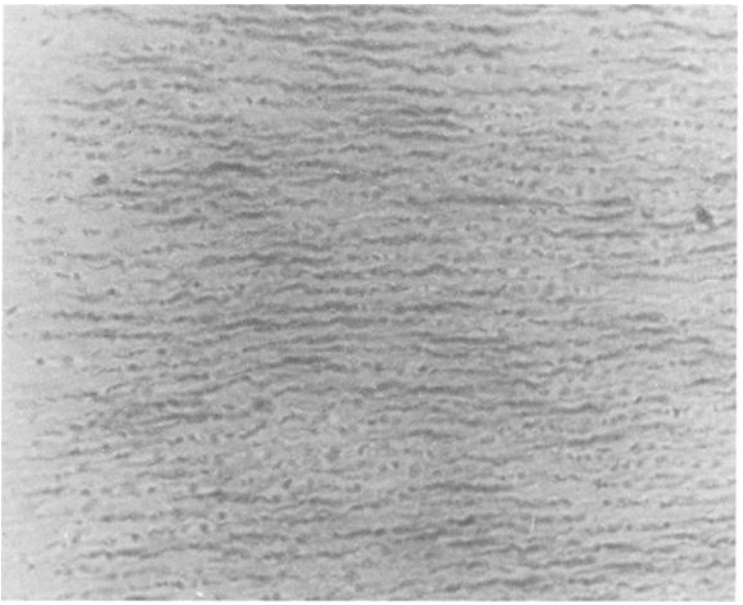

FIG. 7—*A histologic section on decalcified tooth from Case 1 showing hemoglobin in detinal tubules as revealed by this stain for perixidase activity (Lepehne's stain).*

After formalin fixation, teeth from several of the cases failed to give satisfactory peroxidase staining. To ensure that formalin fixation and decalcification procedures would not inactivate peroxidase, we used a dental bit to drill out and collect, as a powder, portions of teeth that were either pink (Cases 4 and 8) or brown-gray (Cases 7 and 9). Unstained portions of the powder in immersion oil on a glass slide had granular material in the dentinal tubules. Such powders smeared on a slide were mixed with gelatin solution, fixed in 95% alcohol, and then stained for hemoglobin by Lepehne's procedure and viewed with or without counterstaining with nuclear fast red. Although the dentin was fragmented by the shearing force of the dental bit, one could see in many of the particles discontinuous brown staining material aligned to reflect a linear distribution in the dentinal tubules. Such staining was more evident in teeth from Case 8 (Fig. 8) than in adult cases; however, powders from Cases 7 and 9, representing zones of gray discoloration, gave positive peroxidase reactivity on prolonged staining. Stains for iron and hemosiderin were negative on all powders.

Pink Teeth in Dogs

A 4-month-old female dog (Dog 1) was anesthetized with intraperitoneal injection of sodium pentobarbital. The animal was then placed in a plastic bag and gas was admitted from a cylinder of 100% carbon monoxide until the animal died. Blood samples were taken by needle from the heart and the carcass was left at room temperature for 16 h. The jaws with adherent soft tissues were removed and the maxilla and mandible were bisected longitudinally. One half of the mandible and maxilla was placed in a plastic bag and about 15 g of soil and water were sprinkled on the specimen. The closed plastic bag was

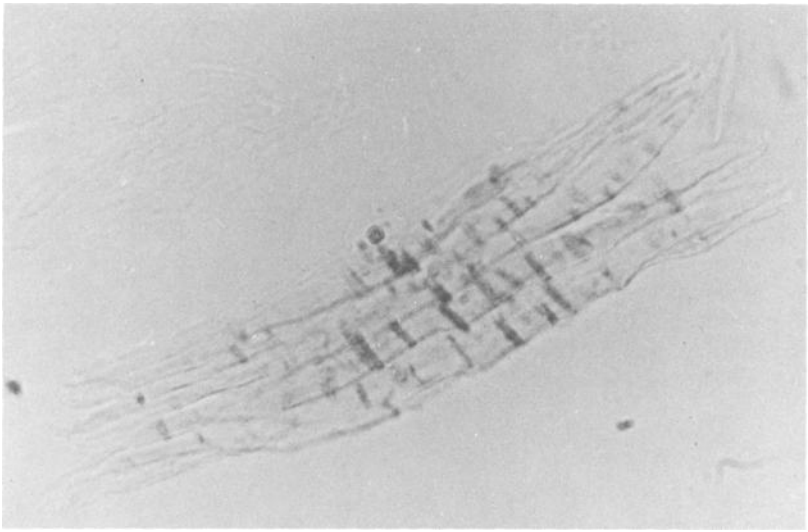

FIG. 8—*Undecalcified dentin fragment from Case 8 showing positive peroxidase staining of material in detinal tubules. Other brown-gray teeth gave similar staining of dentinal tubules (Lepehne's stain).*

immersed in moist sand and allowed to remain undisturbed in the laboratory for 14 days. The remaining half of the maxilla and mandible was covered with a towel in a fume hood with the fan operating for the same period.

At the end of 14 days the specimen in the plastic bag was removed; the teeth had a light pink color and the roots were red. There was minimal red color of the bony sockets. Bloody fluid was present in the pulp chambers of all teeth. Molar teeth had less pulp but were pink. The specimen from the hood had dry, firm soft tissues and white teeth. The contents of the pulp chambers were shrunken, dry, and brown.

Analyses of the immediate postmortem blood by gas chromatography revealed 81% saturation with carbon monoxide. The fluid in the teeth in the moist environment after 14 days in similar analysis was 45% saturated with carbon monoxide.

Two large adult dogs used for pulmonary gas studies were killed with an overdose of sodium pentobarbital and terminal breathing of 100% nitrogen. One animal (Dog 2) died without vascular restriction, but the second (Dog 3) died with a rubber hose ligature around the neck to restrict venous return from the head. There was no discernible pink coloration of the teeth in Dog 3 in the immediate postmortem period. One half of the upper and lower jaws of Dog 2 were mixed with some soil, put in plastic bags, and placed under moist sand for 21 days. The other half of the jaws was placed under a cotton towel in a fume hood with the fan operating. At the end of the 21-day period the teeth from the jaws enclosed in the plastic bags were pink like those of the first dog studied, although the pulp chambers in this animal's teeth were smaller and contained less fluid than did those in the younger dog. The jaw in the fume hood had dry tissues and the teeth remained white.

The jaws from Dog 3 were treated as follows: One half of the maxilla was heated in a plastic bag in a water bath at 165 °F (74 °C) for 3 min. (It had been determined that this temperature caused considerable hemolysis in dog blood similarly heated in a glass tube.) The specimen then remained at refrigerator temperature. One half of a mandible was frozen for 3 days, then thawed and left to remain at refrigerator temperature. One half of the maxilla and mandible was refrigerated only.

At the end of 3 days after heating or thawing the frozen specimens, there was some darkening discernible in the interior of several of the teeth in the specimens. No similar discoloration was seen in the refrigerated specimen. At 6 days pinkness was visible in the canines and incisor and through the crowns of some molars in the heated specimen; there was less pinkness in the same teeth of the thawed specimen. The specimens that were only refrigerated did not show this pink color. At the end of 3 weeks the specimens from Dog 3 were examined in detail. The specimen that was only refrigerated had slight pinkness of the incisors; the heated and frozen specimens had no appreciable increase in pink color from that observed at 6 days. The teeth were extracted and fractured to reveal wet, red gelatinous tissue strands in the pulp chambers and zones of pinkness in the dentin similar to those seen in human teeth.

Such observations suggest that decomposition in a moist environment leads to diffusion of hemoglobin from the pulp chambers into the dentin and that factors such as heat and freezing, which cause hemolysis of red blood cells, accelerate the process.

Discussion

After studying the specimens as described above and reviewing the particulars of previous reports, we are led to postulate a general mechanism for the development of postmortem pink color of teeth. Following death, and with time and suitable conditions, dental pulp tissue may undergo autolysis in which hemoglobin is freed from erythrocytes and maintained in solution. Such hemoglobin diffuses into the dentin through the dentinal tubules. Viewed through the overlying enamel—that is, through the crown—the hemoglobin in the dentin causes the tooth to appear pink. The roots, which have no overlying enamel, have the more red color of hemoglobin. With time and drying, the hemoglobin takes on a brown color and the hemoglobin and accompanying serum proteins in the dentinal tubules progressively impart a gray color to the teeth.

Clearly, the wet gelatinous material in the pulp chamber of the better specimens in this study was autolyzed pulp tissue. These teeth contained enough vascularity and blood for the hemoglobin to give the pulp tissue its red color. Such hemoglobin and serum proteins were recovered from both the pulp chambers and the dentin. Microscopic examination of stained and unstained dentin revealed proteinaceous material and peroxidase activity, probably from hemoglobin, in the dentinal tubules. Such findings indicate the hemoglobin and other proteins in the autolytic pulp tissue enter the dentinal tubules, which are occupied in part by degenerating odontoblastic processes. With time the proteinaceous material in the dentinal tubules appears to dry and is present as plugs that change from pink to brown to gray. The hemoglobin in the latter stage continues to give some peroxidase activity and is not degraded sufficiently that its iron is stainable.

Beeley and Harvey [*3*] demonstrated the presence of hemoglobin or heme derivatives in the pulp tissue of pink teeth, but the extraction and demonstration that the red material in dentin is likewise hemoglobin, as in Case 1, further supports the view that the hemoglobin diffuses into the dentin and, at least in early phases of this process, remains unchanged. More difficulty, similar to that previously reported, was encountered in extracting and demonstrating hemoglobin from the dentin of adult teeth. Such difficulty may be related to the fact that the dentinal tubules are smaller in adults [*1*] and thus it is more difficult to get solution into the dentin to solubilize the proteins. Furthermore, there were probably different states of hydration in the specimens impeding solubilization of the proteins. Such factors required an extended period for proteins in dentin to be extracted and concentrated so that bacterial activity in the solutions probably enhanced degradation of the hemoglobin. Even so, the demonstration of some hemoglobin indicates the pink color of the dentin in these specimens was due to hemoglobin.

The postulated mechanism for the development of pink teeth is further supported by

duplication of this phenomenon under controlled conditions: first, in human teeth by infusion of blood into the pulp chamber and, second, in jaws of dogs allowed to decompose under prescribed conditions.

Forensic odontologists [5] attest that pink teeth are not uncommon in bodies investigated for cause of death. Undoubtedly, they see this phenomenon more than others because they examine teeth more closely and because their services are required for identification in cases in which decomposition that obscures other methods of identification has taken place. These are the conditions in which pink teeth would be expected to occur. We were surprised to have had the opportunity to study the fresh specimens in this study in less than 6 months.

What, then, are the factors leading to postmortem pink teeth? Clearly, there should be enough blood in the pulp chamber so that on hemolysis a sufficient amount of hemoglobin is present to diffuse into the dentin and impart its red color. Pulp chambers in youth are large and vascular but decrease in volume and become less vascular with increasing age and the laying down of secondary dentin [1]. Thus, younger persons would appear to demonstrate this phenomenon more readily than older persons. We have fractured numerous adult teeth extracted in a dental clinic and found the pulp of a large number to be dry and lacking any grossly recognizable blood component; others had a fine thread of red pulp tissue. Such teeth probably would not become pink under any circumstances. Even in dentition where pink teeth are found, there is variability in the pink color that corresponds to the vascularity and blood in the pulp. Incisors, canines, and premolars seem to demonstrate the color better than other teeth. Color in relation to vascularity was demonstrated in Case 6. The one carious tooth had no color and no vascularity of the pulp, but the other teeth had color and yellow-brown pulp chambers, the residuals of dry vascular pulp. Thus, if teeth are to become pink after death, they must have blood in the pulp at the time of death, a factor related to age but variable with the health of the tooth.

A common denominator in the previously reported cases of pink teeth and in the cases in this report is the occurrence of decomposition in a moist environment. The five cases reported by Miles and Fearnhead [2], the five cases reported by Beeley and Harvey [3], and the cases in this report all displayed decomposition changes in a humid environment. For example, Mrs. Evans, the body displaying pink teeth and the first adult victim in the Christie murders, was first autopsied 2 Dec. 1949, some 3 weeks after death. This autopsy report [1] describes decomposition in the face and neck, which were bloated and swollen with exudation of sanguinous fluid from the mouth and nostrils (indicating an adequately fluid oral environment). The body was refrigerated and buried 7 Dec. 1949, without pink teeth having been recorded by the examiner. On exhumation on 18 May 1953, the body was well preserved and the pink teeth were evident. The body was described as lying in a coffin on a bed of somewhat damp sawdust. In this case the teeth were noted to be pink 4½ years after death. The pink coloration of the teeth was probably started by the time of the first autopsy, and the humidity of the grave was sufficient to retain the pinkness of the teeth during the lapsed time.

Four of the five examples of pink teeth reported by Beeley and Harvey [3] were in bodies recovered from water or damp environment at least 30 days after death. Our findings of dry pulp cavity contents in the teeth of dogs at room environment versus fluid contents in damp environment offer experimental verification of the need for moist environment. Thus, requisites for the pink-tooth phenomenon appear to be decomposition leading to hemolysis of erythrocytes, freeing the hemoglobin for diffusion into the dentin, and humidification to keep the pulp protein solubilized so that diffusion can occur. Since pink teeth were noted in Mrs. Evans 4½ years after death, one wonders how long the pink color would remain given a continued moist and dark environment. Those gray teeth described in this report as having pink-brown or gray color had all been subjected to

drying and light before study. The persistence of the pink color in a tooth in a CO_2 environment suggests that an acid condition favors the maintenance of the pink color.

Another possible mechanism for the development of pink teeth deserves consideration. One would question if strangulation, suffocation, or hanging may cause engorgement of the vessels and hemorrhage into the dental pulp and dentin. Kato [*6*] reported purple-red discoloration of the teeth in four cases of death by strangulation examined within 24 h. He described bleeding into the pulp. Beeley and Harvey [*3*] cite observations in 1829 of pink teeth in victims of hanging. Intense congestion of the vasculature of the head could lead to congestion of the dental pulp and possibly bleeding into the pulp. It is improbable that hemolysis would occur, so that color changes would result only from hemorrhage into the pulp or extravasation of erythrocytes into the dentinal tubules. The dentinal tubules are filled by odontoblastic cell processes that should block the intrusion of erythrocytes. We were unable to observe any pink discoloration of the teeth of a dog that died with a ligature around the neck restricting return of blood from the head.

Observations on discoloration of teeth in vivo following trauma may have significance as to mechanisms for this postmortem finding. On the one hand, Grossman [*7*] notes that traumatic injury may cause rupture of blood vessels in the pulp with diffusion of blood into the dentinal tubules. Such teeth are said to present almost immediately a dark pink hue that turns pink-brown some days later. The discoloration persists even after the pulp is removed. Young people are particularly prone to display this phenomenon. The injured pulp may recover, but the pigment resulting from the breakdown of the erythrocytes in the dentinal tubules may persist. Usually the pulp will become necrotic and the hemoglobin will break down to the various color compounds as in bruises. Auslander [*8*], on the other hand, describes a slower pink coloration in trauma. There may be extravasation of blood cells into the pulp, which becomes evident within 1 to 3 weeks as a pink color shining through the crown. When the tooth returns to rest, the blood supply will attempt to reestablish its normal function and existence. The pink color will gradually disappear so that within 2 to 3 months the natural color of the clinical crown will once more be in evidence. More severe trauma may lead to permanent discoloration. Such stained teeth can be bleached back to a natural color by instilling oxidizing agents into the pulp chambers [*9*]. We readily demonstrated a similar bleaching effect by instilling 30% hydrogen peroxide into the incisors of Case 1, which had been stained by the introduction of whole blood into the pulp chamber.

From the foregoing, it is not sufficiently clear that strangulation or hanging can cause hemorrhage into the pulp of sufficient proportions to cause the teeth to become pink in a short time. If so, this mechanism is different from that we propose. Further observations on tooth color changes in strangulation and hanging victims are indicated.

Such conditions as freezing, heating, immersion in fresh water, and exposure to toxins could accelerate hemolysis and predispose to pink color of teeth. An example of early change brought about by fire is Case 5. The second author has noted pink teeth within 24 h of death in a workman killed in a flash fire in a petroleum storage tank. Here, concussion, heat, and organic vapors may have accelerated the process. In our dog experiments, heating and freezing of oral tissues led to accelerated pink discoloration of the teeth.

Previous workers have been interested in the possibility that pink teeth might reflect cause of death. In the Christie murders this question arose because of the use of coal gas in the murders. Beeley and Harvey [*3*] suggested that the pink color results from a carbon monoxide-heme complex differing from the more stable carboxyhemoglobin. Carbon monoxide was used in one dog experiment to see if pulp and dentin contents could be used for toxicologic examinations. Significant levels of carbon monoxide could be recovered from the pulp contents 14 days after death. We think the carbon monoxide had nothing to do with the teeth's becoming pink. In Case 7 the tooth substance ground out from a gray zone in the dentin with a dental bit gave a positive presumptive Koppanyi

(qualitative) test for barbiturates [*10*]. Other evidence indicated this man died of an overdose of barbiturates.

It appears that, in some instances, blood and tissue entrapped in the flask-like tooth may escape some of the degradative processes of decomposition. Such material, subjected to increasingly sensitive and precise toxicological analytic methods, could prove of value in investigating toxic causes of death when incineration, decomposition, or skeletonization has occurred.

Summary

A series of cases is reported in which pink teeth were observed during the postmortem period. Most cases were associated with decomposition in a moist environment. Experimental procedures led to the extraction of pink material from dentin and demonstration that hemoglobin and serum proteins were present. The pink-tooth phenomenon was duplicated in human teeth by instilling into the pulp chambers whole blood and blood with the red cells hemolyzed. The change was manifested in teeth of dogs after freezing, heating, and decomposition in a moist environment. The authors postulate that pink teeth occur as a result of breakdown of red blood cells in the pulp chamber of the tooth and diffusion of hemoglobin and other serum proteins into the dentin via the dentinal tubules. Histochemical studies show that the brown or gray material in some teeth subjected to postmortem aging is probably hemoglobin and serum proteins. Factors of age, vascularity of the pulp chamber, and postmortem conditions are discussed in relation to the postmortem development of pink teeth.

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