Distribution of ^{14}C-formaldehyde after pulpotomy with formocresol

David R. Myers, DDS, MS
H. Kenneth Shoaf, DDS
Thomas R. Dirksen, DDS, PhD
David H. Pashley, DMD, PhD
Gary M. Whitford, PhD, DMD
Keith E. Reynolds, BS, Augusta, Ga

Pulpotomies were performed on rhesus monkeys with use of formocresol to determine if there was uptake of ^{14}C-formaldehyde into the systemic circulation after formocresol pulpotomies. Five-minute exposure of pulpal tissue to the ^{14}C-formocresol resulted in the systemic absorption of approximately 1% of the dose. Two hours of exposure of pulp tissue to the ^{14}C-formocresol did not increase the systemic absorption. Multiple sequential pulpotomies resulted in proportionately higher systemic absorption of ^{14}C-formaldehyde.

Application of ^{131}I to pulpotomy sites indicated that formocresol compromises the microcirculation of the dental pulp. Autoradiography disclosed extensive concentrations of ^{14}C-formaldehyde in the pulp, dentin, periodontal ligament, and bone.

Because of its apparent clinical success, formocresol is the preferred agent for performing pulpotomies on deciduous teeth.[1,2] Formocresol was introduced by Buckley in 1904.[3] In 1923, Sweet advocated a five-appointment pulpotomy, which was subsequently modified to a three-appointment procedure.[4,5] The one-appointment pulpotomy produced equally satisfactory results and is in common use today.[6]

Formocresol contains 19% formaldehyde, 35% cresol, and 15% glycerin in a water base.[7,8] Formaldehyde produces fixation of tissues and has strong disinfecting properties.[8] The tricresol is empirically included in the preparation to reduce the irritating properties of formaldehyde.[8]

A high rate of clinical success has been reported for pulpotomies performed on deciduous teeth with the use of formocresol.[6,9-13] Clinical success is usually considered as the absence of factors such as pain, fistulas, mobility, and radiographic evidence of pathologic conditions.

Histologic evaluation of the pulp after pulpotomies with use of formocresol shows diverse results. Responses ranging from apparent fixation of portions of the pulp tissue to areas of inflammation and necrosis have been reported.[9,10,12-18] Results of studies concerned with the biologic effect of formocresol on connective tissue indicate that formocresol is toxic to cells in the immediate area and interferes with the physiologic activity of surviving cells.[19-21] A reduction in the concentration of formocresol is accompanied by a reduction in its cytotoxic effects.[20,21]

Results of in vitro studies have shown that formaldehyde and tricresol diffuse through the apical foramen within minutes after formocresol is sealed in the root canal.[22] If this occurs under in vivo conditions, chemical irritation to the periapical tissue may occur. Other agents placed on vital pulp tissue have been shown to pass into the systemic circulation.[23-27] There is a lack of information concerning the possibility of systemic absorption of formocresol from a pulpotomy site. This study was designed to determine if formaldehyde enters the systemic circulation during pulpotomy procedures with use of formocresol.

Materials and methods

Radioactive formocresol was prepared by mixing 250 μCi aqueous ^{14}C-formaldehyde (New England Nuclear) with 0.25 ml of Buckley Formular Formocresol (King Specialty Co.) and sufficient glycerol (10 μl) to yield a homogenous solution. This gives a final activity that approximates 1.5×10^6 dpm/μl (disintegration per minute/μ) formocresol. The ^{14}C is a radioactive tracer used for identification and quantification of formaldehyde; it behaves chemically like the formaldehyde in Buckley's solution.

Five rhesus monkeys (two females and three males, weighing 2.7 to 4.6 kg) were anesthetized with phencyclidine hydrochloride, 1.25 mg/kg, intramuscularly, supplemented with urethan, 1 gm/kg, intraperitoneally as needed. Catheters were placed in the femoral artery for blood sampling and in the femoral vein for intravenous administration of fluids as well as for injection of isotopes as a bolus. A catheter was passed through the urethra into the bladder for timed urine collections.

Unless otherwise stated, pulpotomies were performed on deciduous and permanent molars isolated with a rubber dam. A cotton pellet containing 10 or 20 μl ^{14}C-formocresol was placed within the pulp chambers for five minutes, removed, and the teeth were filled with zinc oxide and eugenol cement. In one experiment, the pellet containing the radioactive agent was sealed in the tooth throughout the duration of the sampling. Multiple pulpotomies were performed on two animals at 30-minute intervals. Blood samples (2 ml) were collected in heparinized syringes before the initial pulpotomy and then at 15-minute intervals thereafter. Urine samples were collected for timed 30-minute periods and the bladder was evacuated at the end of each period.

Whole blood was spun at 2,000×g for ten minutes to separate the formed elements from plasma. Aliquots of urine or plasma (1 ml) were added to 15 ml of a liquid scintillation cocktail and

THE AUTHORS

Dr. Myers is associate professor and chairman and Dr. Shoaf is assistant professor, department of pedodontics; Dr. Dirksen is professor and coordinator, department of oral biology and biochemistry; and Dr. Pashley is associate professor, Dr. Whitford is assistant professor, and Mr. Reynolds is research assistant, department of oral biology and physiology, Medical College of Georgia School of Dentistry, Augusta, Ga 30902. Address requests for reprints to Dr. Myers.


MYERS


SHOAF


DIRKSEN


PASHLEY


WHITFORD


REYNOLDS

counted in a Packard Liquid Scintillation Counter (Model 3320). Absolute dpm was measured by internal standardization and all samples were counted to 10,000 counts.

Plasma proteins from one monkey were subjected to polyacrylamide gel electrophoresis to determine if radioactivity of the blood was associated with any particular plasma fraction.[28] After they were stained, the gels were scanned, sectioned, and counted in a Beckman LS 330 Scintillation Counter using Bray's solution.

To grossly localize the formocresol within the pulp and surrounding tissue, a portion of one mandible containing two molars that had been treated with formocresol pulpotomies was excised with use of a high-speed dental handpiece. The bone and teeth were embedded in methyl methacrylate and sectioned with a dental disk. These sections were placed between two layers of dental film for two weeks to localize the radioactivity before the film was developed.

^{14}C-formaldehyde used to estimate volumes of distribution was prepared by dissolving 250 μCi (0.1 ml) in 1.0 ml isotonic saline solution. The theoretical basis behind this volume of distribution technique has been discussed elsewhere.[29] After measuring absorption of ^{14}C-formocresol from pulpotomy sites, sufficient ^{14}C-formaldehyde was injected intravenously as a bolus to raise the level in the blood 100 times higher than that achieved through absorption during the pulpotomy. Samples of plasma were obtained at 0, 5, 15, 30, 60, 90, and 120 minutes after injection of the bolus to permit estimation of the kinetics of isotope dilution. With use of a semilogarithmic plot of the change of the concentration of ^{14}C-formaldehyde in plasma, (dpm/ml of plasma) in comparison to time, the 60-, 90-, and 120-minute concentrations were extrapolated back to zero time to obtain an estimate of the volume of distribution of ^{14}C-formaldehyde. This was calculated as follows: volume = quantity (dpm) injected − quantity (dpm) excreted in urine divided by zero time concentration (dpm/ml). This volume is expressed as a percentage of animal body weight.

The total amount of ^{14}C-formocresol absorbed from the pulpotomy site was calculated as follows: total absorption = (dpm/ml plasma) × (volume of distribution) + amount excreted in urine during that time.

Absorption was expressed in two ways. Initially, total absorption was expressed as a percentage of the total dose placed on the cotton pellet. A second method involved dividing the total dpm absorbed at a given time by the activity of ^{14}C-formocresol on the pellet (1.5×10^{8} dpm/μl) to obtain a fractional absorption value that represents the volume of formaldehyde absorbed per unit of time.

After completing the studies on the volume of distribution, a fresh pulpotomy was performed in a maxillary permanent molar and the pulp stumps were treated with Buckley's formocresol for five minutes. Immediately after removal of the cotton pellet containing the formocresol, a new cotton pellet containing 10 μl of ^{131} NaI (1 mM NaI in Krebs-Ringer phosphate) buffer was sealed in the pulp chamber with zinc oxide and eugenol cement to determine whether the microcirculation was capable of absorption after it was exposed to formocresol. Blood samples (2 ml) were drawn into heparinized syringes at 0, 5, 15, 30, 60, 90, and 120 minutes after introducing the ^{131}I tracer solution. The plasma was separated as before and 1 ml of plasma was counted in a gamma well counter, which does not detect residual ^{14}C-activity. After collecting the 120-minute blood sample, another pulpotomy was performed on the contralateral maxillary first permanent molar to serve as a nonformocresol-treated control. After controlling hemorrhage with direct pressure, a cotton pellet containing 10 μl of ^{131}I was placed and blood samples were collected as previously described for identical processing.

Results

■ *Plasma levels of ^{14}C-formaldehyde:* Figure 1 shows the time course of the appearance of ^{14}C-formaldehyde in the plasma of five monkeys (M1-5) after applying radioactive formocresol during pulpotomy procedures. The lines designated M1 and M2 represent data obtained from a single five-minute exposure to ^{14}C-formocresol in two animals. The line designated M3 shows the change in plasma ^{14}C activity in a third monkey in which the ^{14}C-formocresol pellet was sealed inside the pulp chamber. Note the similarity of the absorption curves for these three monkeys, whether the pellets were left in situ or were removed after five minutes.

Multiple pulpotomies were performed on two of the animals represented in Figure 1. The pellets containing radioactive formocresol were left in place for only five minutes in each case. In M5,

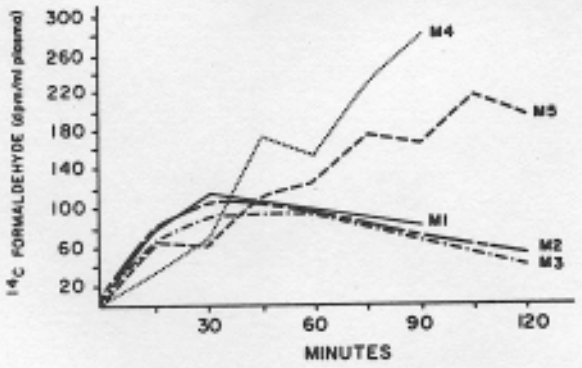

Fig 1 ■ Concentrations of ^{14}C-formaldehyde. Pulpotomies were performed on M1 and M2 at zero time, and ^{14}C-formocresol was placed in pulp cavity for five minutes and then removed. In M3, agent was sealed in place with zinc oxide and eugenol. Pulpotomies were performed on M4 at 0, 30, 60, minutes; on M5 at 0, 30, 60, 90 minutes (five-minute applications).

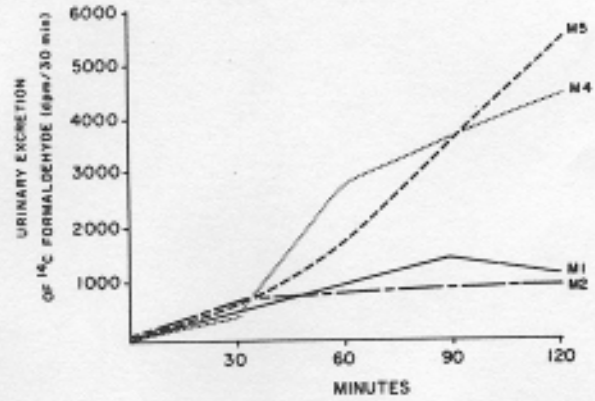

Fig 2 ■ Urinary excretions of ^{14}C-formaldehyde. Urinary samples from M3 were not collected.

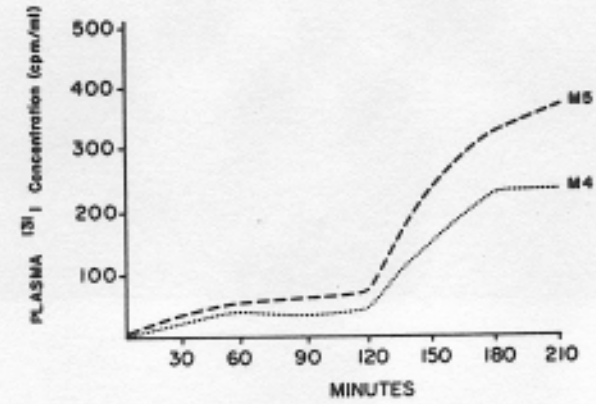

Fig 3 ■ Levels of ^{131}I in plasma after application to pulpotomy sites. At time 0, ^{131}I was applied to formocresol-treated site; at 120 minutes, ^{131}I was applied to untreated site.

four successive pulpotomies led to progressively higher concentrations of ^{14}C-formaldehyde in plasma. The three successive pulpotomies performed on M4 yielded the highest levels of ^{14}C in the blood.

In the electrophoresis of plasma proteins, no radioactivity could be identified with any particular plasma fraction. This was probably due to the large dilution of radioisotope and the small sample taken for electrophoresis.

■ *Urinary excretion of ^{14}C-formaldehyde:* Figure 2 plots the urinary excretion—(concentration of ^{14}C-formocresol) × (rate of flow of urine)—of ^{14}C-formaldehyde as a function of time. Note the gradual increase in the amount of ^{14}C-formaldehyde excreted during each 30-minute period in M1 and M2, each of which underwent only one pulpotomy. The much higher rates noticed for M4 and M5 reflect the multiple pulpotomies performed in succession and in correlation with the higher concentrations of plasma as shown in Figure 1.

■ *Levels of ^{131}I in plasma after application to pulpotomy sites:* Concentrations of ^{131}I in plasma after application of the isotope to formocresol-treated and nontreated pulpotomy sites are shown in Figure 3. Little ^{131}I was absorbed into the circulation in M4 and M5 up to 120 minutes after treatment. Similar data were obtained whether the ^{131}I was placed on the pulp tissue either five minutes or two hours after treatment with formocresol. At the end of 120 minutes, fresh pulpotomies were performed on contralateral teeth with no application of formocresol, but the same quantities of ^{131}I were placed in the pulp chambers. The absence of pretreatment with formocresol allowed larger rates of absorption of ^{131}I into the circulation during the next 120 minutes as reflected by the higher radioactivities in plasma shown in Figure 3.

■ *Volumes of distribution and total absorption of isotopes:* The average volume of distribution of ^{14}C-formaldehyde in five monkeys was 144± 14.1% of body weight (Table 1). The volume of distribution of ^{131}I in three monkeys was 61.3 ±1.0% of body weight.

Total absorption of ^{14}C-formaldehyde in five monkeys is shown in Table 2. In M1, M2, and M3, the peak of absorption occurred 30 minutes after the single exposure to ^{14}C-formaldehyde and accounted for 1% of the dose (20 μl containing

Table 1 ■ Volumes of distribution of ^{14}C-formaldehyde (FA) and ^{131}I.

		Volumes of Distribution			
MONKEY	BODY WT.	^{14}C-FA	% BW*	^{131}I	% BW
1	3.3 kg	3650 ml	110.6%	--	--
2	3.0 kg	3952 ml	131.7%	--	--
3	2.9 kg	5293 ml	182.5%	1737 ml	59.9%
4	4.6 kg	5667 ml	123.2%	2788 ml	60.6%
5	2.8 kg	4822 ml	172.2%	1772 ml	63.3%
$\bar{x}$ + SEM			144.0 ± 14.1		61.3 ± 1.0

*%BW = Volume of distribution of agent (ml) /Body weight in ml (1 gm = 1 ml)

3×10^7 dpm) on the cotton pellets. When expressed in microliters (μl), this represents 0.2 to 0.27 μl formaldehyde. In M4, in which three pulpotomies were performed at 0, 30, and 60 minutes (10 μl/pulpotomy), the total absorption increased with each pulpotomy procedure. When expressed as a percentage of the cumulative dose, absorption was only moderately higher than that seen in M1, M2, and M3. However, the absorption was approximately four times higher than it was in M1, M2, and M3 when expressed in microliters.

Because it is well known that formaldehyde is a toxic substance that binds to and fixes proteins, a second radioactive tracer, ^{131}I, was used as a control. The total absorption of ^{131}I from pulpotomy sites is shown in Table 3. The total absorption of ^{131}I was generally higher (compare Tables 2 and 3) than that of ^{14}C-formocresol (up to 54% of the dose in comparison to 4% of the dose). Pretreatment of pulp tissue with formocresol substantially lowered absorption of ^{131}I from pulpotomy sites (Table 3). Ratios of radioactivity in plasma were in the range of 5 to 1 in favor of the nontreated pulpotomies.

■ *Autoradiography of teeth treated with formocresol:* Sections of two teeth that had been embedded in methyl methacrylate after treatment with ^{14}C-formocresol are shown in Figures 4 and 5. The top portion of each figure represents an autoradiogram, which was prepared by exposing the section (bottom portion) to X-ray film for two weeks. Figure 4 represents a section of the teeth at or just apical to the bifurcation of the roots. Note that the radioactive material is not confined to the pulp canals, but is also prominently located within the spaces of the periodontal membrane. The ^{14}C-formaldehyde is randomly distributed throughout the entire osseous surface, but is not apparent on the acrylic support.

Figure 5 shows a section of the same teeth and bone near the tips of the roots. The outline of the

Table 2 ■ Total absorption of ^{14}C-formaldehyde.

		TOTAL ABSORPTION		
MONKEY	TIME (Min)	ABSORPTION (dpm)	% DOSE	μl/TIME
1	5 min	197100	0.66	0.13
	30 min	405686	1.35	0.27
	60 min	314890	1.05	0.21
	90 min	293500	0.98	0.20
2	5 min	275912	0.92	0.18
	15 min	404014	1.34	0.27
	30 min	522902	1.74	0.35
	60 min	414648	1.38	0.28
	90 min	336026	1.12	0.22
	120 min	276108	0.92	0.18
3	5 min	213408	0.71	0.14
	30 min	355680	1.19	0.24
	60 min	375440	1.25	0.25
	120 min	158080	0.53	0.11
4	15 min	181344	1.21+	0.12 +
	30 min	374500	2.50	0.25
	45 min	974724	3.25	0.65
	60 min	892500	2.98	0.60
	75 min	1314744	2.92	0.87
	90 min	1579000	3.51	1.05
5	15 min	323074	2.15+	0.22+
	30 min	289852	1.93	0.19
	45 min	530420	1.77	0.35
	60 min	604325	2.01	0.40
	75 min	848872	1.89	0.57
	90 min	804140	1.79	0.54
	105 min	1022264	1.70	0.68
	120 min	945828	1.58	0.63

The cotton pellet used in Monkey's 1-3 contained 20 μl ^{14}C-formocresol while those used in Monkeys 4 and 5 contained 10μl.

*While the absolute amount of ^{14}C (dpm) absorbed increased with successive pulpotomies in Monkeys 4 and 5, the % dose did not increase as rapidly since the absolute absorption is divided by the total cumulative dose.

+The volume of ^{14}C absorbed increased with each successful pulpotomy due to the addition of relatively constant fractional absorprions of each individual dose.

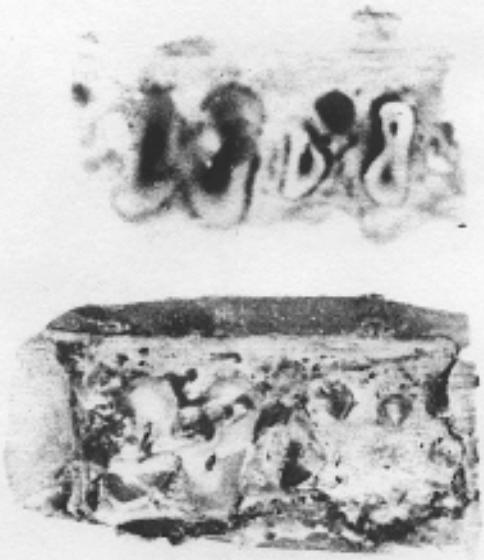

Fig 4 ■ Autoradiograph (at top) of teeth receiving pulpotomies with ^{14}C-formocresol shows section at or apical to bifurcation of roots. ^{14}C-formaldehyde is located in pulp canals, space of periodontal membrane, and entire osseous surface. Bottom of photo shows block of acrylic with teeth embedded.

Fig 5 ■ Autoradiograph (at top) of same teeth and bone sectioned near root tips. Outline of roots and pulp canals are visible. Little radioactivity is distributed throughout bone at this level. Bottom of photo shows block of acrylic with teeth embedded.

Table 3 ■ Total absorption of ^{131}I.

			TOTAL ABSORPTION			
MONKEY	FC#	TIME	(CPM)	NET CPM*	% DOSE	μl/UNIT TIME
4	+	5 min	41820	--	2.53	0.25
		15 min	94790	--	5.74	0.57
		30 min	88300	--	5.35	0.54
		60 min	156900	--	9.51	1.02
		90 min	186900	--	11.33	1.13
		120 min	189584	--	11.49	1.15
	-	130 min	401472	211888*	12.84*	1.28*
		140 min	512992	323408	19.60	1.96
		155 min	755000	565416	34.27	3.43
		185 min	892000	702416	40.89	4.26
		215 min	1075000	885416	53.66	5.37
5	+	5 min	10632	--	0.64	0.06
		15 min	7088	--	0.43	0.04
		30 min	39200	--	2.38	0.24
		60 min	58990	--	3.58	0.36
		90 min	47050	--	2.85	0.29
		120 min	70880	--	4.30	0.43
	-	130 min	93916	23036*	1.40*	0.14
		140 min	205552	134672	8.16	0.82
		155 min	304784	233904	14.18	1.42
		185 min	421736	350856	21.26	2.13
		215 min	425290	354400	21.48	2.15

#+ indicates that a pulpotomy was performed on a maxillary first permanent molar. A cotton pellet moistened with Buckley's Formocresol solution was left in place for five minutes, then removed. It was replaced by a cotton pellet containing 10 μl (1.65 x 10^6 cpm) ^{131}I which was sealed into the pulp chamber with ZOE.

- indicates a second pulpotomy was performed on the contralateral maxillary first permanent molar. After controlling hemorrage, no formocresol treatment was done. Five minutes post-pulpotomy, a cotton pellet containing 10μl ^{131}I which was sealed into the pulp chamber.

* The cumulative absorption (cpm) at 120 minutes in the first pulpotomy was subtracted from all subsequent values to obtain net values above the previous absorption values.

roots and pulp canal are easily observed on the autoradiogram. Little radioactivity is distributed throughout the bone at this level and none is evident on the acrylic block.

Discussion

Results of this study show that systemic absorption of formaldehyde occurs after the application of formocresol to a pulpotomy site. The possibility of systemic absorption of an agent must be considered before using it to treat vital pulp tissue.

This method provides a direct approach to detecting systemic absorption as well as for quantitating the results. The data represented in Figure 1 and Table 2 suggest that there is little difference in total absorption of ^{14}C-formaldehyde, whether the material is left in the pulp chamber for five minutes or for 120 minutes. In both cases, concentrations of radioactivity in plasma peaked at 30 minutes, thus suggesting that absorption is self-limiting. In other words, there may be a brief but relatively rapid absorption of ^{14}C-formaldehyde during the first few minutes, but the contact causes vessel thrombosis, thereby limiting further systemic accumulation. Further support for this hypothesis comes from the experiments with ^{131}I. Only a moderate absorption of ^{131}I was observed from formocresol-treated pulpotomy sites, whereas large, cumulative absorptions were found from nontreated sites (compare Tables 2 and 3). These data are consistent with the view that there is an impaired microcirculation in formocresol-treated tissue relative to that of nonformocresol-treated controls. The damage to the microcirculation may partially account for the varying histologic findings that have been reported in the literature.[9,10,12-17] It may also account for the observation that a single, five-minute application produces the same clinical result as longer or repeated applications, as originally advocated by Sweet.[4,5] To our knowledge, this report is the first to indicate that the functional properties of microcirculation of the dental pulp are impaired by treatment with formocresol.

Estimates of total absorption of ^{14}C-formaldehyde or ^{131}I from pulpotomy sites require quantitation of urinary excretion as well as the volumes of distribution of these substances. The fraction of the absorbed dose appearing in plasma is deceivingly small because the tracer is diluted, bound, metabolized, or any combination of the three. Table 1 indicates that the volume of distribution of ^{14}C-formaldehyde averages 144% of animal body weight. This suggests various possibilities such as that formaldehyde is bound to tissues, exhaled as ^{14}C-formaldehyde or ^{14}C-carbon dioxide, or, more likely, a combination of the two. The large volume of distribution must be considered in such studies or the total systemic absorption will be grossly underestimated. Results of the studies on the volume of distribution indicate that distribution of both formaldehyde and iodine does not achieve a steady state (that is, monoexponential decay) before 60 minutes. Thus, the data obtained before then are subject to uncertainty. The volume of distribution of ^{131}I is also relatively large (61% in Table 1). We are not aware of any previous reports of the volume of distribution of this substance in the rhesus monkey. Although a volume of distribution of 61% suggests that ^{131}I has equilibrated with total body water, it does not rule out uptake by other tissues (thyroid and salivary glands).

We have no direct proof that the ^{14}C-radioactivity detected in the plasma and urine was still in the form of ^{14}C-formaldehyde. Because of the relatively low blood levels obtained, chromatographic identification of the activity was not attempted. This is not a serious criticism because the detection of radioactivity in any form indicates ^{14}C-formaldehyde was absorbed systemically from pulpotomy sites. The fact that it was filtered at the glomerulus and appeared in the urine would suggest that it was not all protein-bound.

The clinical significance of the systemic absorption of these quantities of formaldehyde is not known. Even small children are much larger than the monkeys used in this study (that is, they have much larger volumes of distribution). This factor might result in proportionately lower concentrations of formaldehyde in plasma. However, the cross-sectional area of the pulp tissue available for absorption of the agent is much greater in humans than in monkeys. This might allow similar concentrations in plasma to be obtained. The possibility that a specific tissue binds or concentrates these agents cannot be precluded without further study. Other compounds containing formaldehyde (such as N2) are in clinical use and their possible systemic uptake must be considered. Further research is indicated to determine the significance of the systemic uptake of this material.

Although one might expect the absorption of these tracers to occur through pulpal vessels,

which exit at the apex of the roots, preliminary autoradiographic results indicate extensive ^{14}C in the periodontal ligament, dentin, and bone as well as in the pulp (Fig 4). Whether this finding is due to lateral or accessory canals draining into the periodontal ligament or to diffusion through the dentin itself is unknown.

Our assumption that ^{14}C-activity, which appears in plasma from a mixture of ^{14}C-formaldehyde and cresol, can be equated with absorption of the cresol moiety of the mixture must remain speculative pending further research. It is clear, however, that the technique used permits convenient, quantitative determination of the degree of systemic absorption of agents placed in teeth. This may be useful for future investigations of the systemic absorption of other agents used in dental treatment.

Summary

The purpose of this project was to determine whether there is uptake of ^{14}C-formaldehyde into the systemic circulation after pulpotomy with formocresol.

Pulpotomies were performed on deciduous and permanent molars of five rhesus monkeys with use of formocresol, which contains ^{14}C-formaldehyde. The rate at which ^{14}C-formaldehyde appeared in plasma and urine was observed for two hours. A five-minute exposure of pulpal tissue to ^{14}C-formocresol resulted in the systemic absorption of approximately 1% of the dose placed in the tooth. Two hours of exposure of pulpal tissue to ^{14}C-formocresol did not increase the systemic absorption. Multiple, sequential pulpotomies performed on the same animal resulted in proportionately higher systemic absorption of ^{14}C-formaldehyde.

^{131}I applied to formocresol-treated pulpotomy sites was absorbed at a moderate rate, whereas ^{131}I applied to sites not previously treated with formocresol resulted in large, fractional, systemic absorptions, which indicates that formocresol compromises the microcirculation of the dental pulp.

Autoradiographic results indicate extensive concentrations of ^{14}C-formaldehyde in the periodontal ligament, bone, dentin, and pulp.

Results of timed urinalysis disclosed a substantial excretion of ^{14}C-formaldehyde, indicating that it was filtered at the glomerulus and is not all protein-bound.

Further studies are indicated to determine the significance of the systemic absorption of formaldehyde.

This study demonstrates that materials placed on vital pulp tissue may be absorbed into the systemic circulation. This fact must be considered when agents for vital pulp therapy are selected.

The techniques used in this study permit convenient, quantitative determination of the degree of systemic absorption of agents placed in teeth.

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* Foley's Footnotes

For centuries the books on social behavior have given good attention to oral hygiene, with emphasis on the impressions made on the beholder by the condition of the teeth. In his *Booke of the Demeanor* (1619), Richard West enjoined his readers to

Keep white thy teeth and wash thy mouth
With water pure and clean,
And in that washing mannerly
Observe and keep a mean.

The Book of Nurture, compiled by Hugh Rhodes in 1475, reflects a selective tolerance toward picking of the teeth:

Pick not thy teeth with thy knyfe
Nor with thy fingers ende
But take a stick, or some clean thyng,
Then doe you not offende.

The *Refined Courtier,* published in 1679, offered these admonitions on table manners related to the public exhibition of oral hygiene: "Beward of rubbing your teeth with your napkin. . . . And in the sight of others do not wash your mouth, or, if you do, spit not out the wine or water before them. . . . And when the cloth is taken away, it is not decent to pull a case of tooth-picks out of your pocket."

Some startling lessons in the etiquette of oral hygiene are found in the early 16th-century *Galateo; or a Tretise* (sic) *on Politeness and Delicacy of Manners,* by Giovanni de la Casa (reprinted in Baltimore, 1811):

> When the table is cleared, to carry about your toothpick in your mouth, like a bird going about to build his nest, or to stick it behind your ear . . . is no very genteel custom.
> They also are mistaken . . . who carry their toothpick cases hanging down from their necks.

At the age of 15 George Washington wrote a little book of 110 rules governing polite behavior. It was published in 1942 as *George Washington's Rules of Civility and Decent Behavior.* One of George's rules was "Cleanse not your teeth with the table cloth, napkin, fork, or knife."

In *Appleton's Journal* of March 7, 1874, there is a combination of editorial comment and couplet concerning a problem in etiquette that still prevails nearly 100 years later: "Here is an essential principle of politeness so wedded to sweet verse that even a child cannot misunderstand or forget it: 'In company your teeth to pick, Would make refined beholders sick.' "

One of the strongest "hints" in *Hints on Etiquette and the Usages of Society* (London, circa 1840) is this gem: "Do not pick your teeth much at table, as, however satisfactory a practice to yourself, to witness it is not a pleasant thing." But the toothpick still endures as a repulsive device in the public display of teeth cleaning!

Gardner P. H. Foley