JOURNAL OF ENDODONTICS
Printed in U.S.A.
VOL. 28, NO. 4, APRIL 2002

Hemostatic Efficacy and Cardiovascular Effects of Agents Used During Endodontic Surgery

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The hemostatic efficacy, as well as the cardiovascular effects, of two hemostatic agents currently used during endodontic surgery was examined. The hemostatic agents used were epinephrine pellets (Racellet pellets) or 20% ferric sulfate (Viscostat). Patients were assigned to one of two experimental groups. Blood pressure and pulse rate were recorded pre- and postoperatively and at three additional times during the surgery (root-end resection, root-end preparation, and filling). The adequacy of hemostasis was rated by the surgical operator. Results indicated that there is no significant change in cardiovascular effects when using either of these hemostatic agents. Except in one case where ferric sulfate was the agent, both agents produced surgical hemostasis that allowed for a dry field for root-end filling.

Many factors influence the success of endodontic surgery. Hemostasis during surgical procedures is important for successful case management. Excessive bleeding not only obscures visualization of the surgical field but also creates difficulty in maintaining a dry field for placement of a technique-sensitive root-end filling material (1, 2).

Many agents have been suggested as adjuncts to help achieve adequate hemostasis. These include bone wax, thrombin, gelatin-based sponge, bovine collagen, ferric sulfate, and vasoconstrictors (3–7). These agents are locally applied substances that are employed to arrest excessive bleeding. They generally aid in coagulation by inducing rapid development of an occlusive clot. Hemostatic agents used during endodontic surgery are intended to control bleeding from small blood vessels or capillaries. Witherspoon and Guttman (8) have written a review of methods for hemostasis during endodontic surgery.

It has been reported that some of these agents, such as bone wax and ferric sulfate, may produce an inflammatory response if left in situ (5, 6). It has also been reported that the use of vasoconstrictors for local hemorrhage control in endodontic surgery may produce a systemic-vascular response (7, 9).

The purpose of this study was to evaluate two of these agents. Ferric sulfate and epinephrine-impregnated cotton pellets were evaluated for their ability to achieve hemostasis during endodontic surgical procedures and for cardiovascular changes during the use of these agents.

MATERIALS AND METHODS

Written, informed consent was obtained from 39 patients in the School of Dentistry, Oregon Health Sciences University. All patients required endodontic surgery that included root-end resection and root-end filling. All surgical procedures were performed by second-year, post-graduate endodontic students. Each patient's medical history was reviewed. Patients classified as ASA I or II were included in the study (10).

The patients were randomly assigned to one of two groups. In group I, hemostasis was achieved by using 20% ferric sulfate (Viscostat, Ultradent, South Jordan, UT). In group 2, hemostasis was achieved by using racemic-epinephrine cotton pellets (Racellet #3, Pascal Company, Inc., Bellvue, WA). A digital blood-pressure monitor (Omron, Vernon Hills, IL) was applied to the left wrist of each patient, and preoperative blood pressure and pulse were recorded. After anesthesia was achieved, the operator proceeded with the indicated endodontic surgery. Once the surgical site was exposed, the operator determined the need for additional hemostasis for the procedure to be performed. If additional hemostasis was needed, ferric sulfate or racemic-epinephrine cotton pellets were used, according to the group to which the patient had been randomly assigned. Ferric sulfate was used in the following manner: a Dento-Infuser tip (Ultradent) was used to apply the ferric-sulfate solution to the bleeding surface of the bone. After the surgery was completed, the site was rinsed with copious amounts of sterile, normal saline, and the area was curetted to remove any clotted material. For patients in group 2, epinephrine pellets (1 to 7 pellets) were applied directly to the bony crypt and left for 2 to 4 min, and then removed. After the surgical procedure, copious irrigation of surgical site was accomplished with sterile saline, and the bony crypt was examined with the use of the surgical microscope to ensure that there were no remaining cotton-pellet fibers. The adequacy of hemostasis was determined by the surgical operator, according to written guidelines, and recorded as adequate or inadequate. Adequate hemostasis was defined as the root-end preparation being dry and hemorrhage-free during root-end filling procedures. Inadequate hemostasis was defined as the inability to keep the root-end preparation dry and hemorrhage-free during root-end filling procedures. The patient's blood pressure and pulse

were recorded immediately after the placement of ferric sulfate or epinephrine pellets and again at 1, 5, and 10 min after placement. A final blood pressure was obtained before the patient's dismissal. ANOVA ($p < 0.05$) was used to evaluate any differences in blood pressure and pulse between groups 1 and 2.

RESULTS

Additional hemostatic measures were not required during six surgical procedures. The level of hemostasis in these six cases was adequate without a hemostatic agent. There were no significant changes in blood pressure or pulse at any time period for experimental groups 1 and 2. In group 1 (ferric sulfate), adequate hemostasis was achieved in 15 out of 16 cases, with one case having inadequate hemostasis. In group 2 (epinephrine pellets), adequate hemostasis was achieved in all 17 cases.

DISCUSSION

Sympathomimetic-amine vasoconstrictors, such as epinephrine, norepinephrine, and phenylephrine have been utilized for hemorrhage control during surgery (2). These vasoconstrictive amines exert their effects by binding to and interacting with adrenergic receptors that are located in various tissues throughout the body. Epinephrine is a powerful stimulator of both alpha- and beta-adrenergic receptors. The alpha-adrenergic receptors predominate in tissues, such as oral mucosa and periodontium (11). When bound to the alpha 1- and alpha 2-adrenergic receptors, epinephrine elicits potent vasoconstrictive effects. The beta 2 effects may include an increase in heart rate, cardiac output, and vasodilatation of skeletal muscle. Racellet #3 pellets contain an average of 0.55 mg (0.42 to 0.68 mg/pellet) of racemic-epinephrine hydrochloride per pellet, of which one-half is the pharmacologically active L-form.

The results from this study showed very good hemostasis using the racemic-epinephrine pellets with no evident cardiovascular changes. One possible explanation is that the vasoconstrictive effect on the capillaries is so localized and immediate that there is no uptake of these agents. The vasoconstrictive effects of the local anesthetic on tissues may act conjointly with these agents in constricting capillaries and preventing further uptake of epinephrine. Any changes in blood pressure were compared with the preoperative findings. Our findings of no change in blood pressure and pulse agree with the findings of Besner (7) but differ with Gogerty et al. (9). Differences might be due to the use of dogs in the Gogerty study or the differences in amount or delivery of the epinephrine.

Hemostasis, with Viscostat, results from a chemical reaction of ferric-sulfate ions with the blood and the low pH of the solution, giving a plug that occludes capillary orifices. Systemic absorption is unlikely because the vascular supply is isolated by the coagulum. The surgical site should be rinsed copiously to remove any remaining ferric sulfate. In two studies, it was found that ferric sulfate damages bone and delays healing if left *in situ* but not if removed (6, 12).

Maintaining strict control of bleeding during endodontic surgery enhances optimal visibility and may decrease the length of surgery. Technique-sensitive materials, such as dentin-bonding agents and composites used for root-end filling require a blood-free environment for successful placement (1, 2). Kim et al. (13) believe that the epinephrine-pellet technique is the most efficient for hemostasis in the bony crypt and reserve ferric sulfate for bone-surface hemostasis, such as small bleeders around the osteotomy on the buccal plate.

Our results indicate that local hemostatic measures were required in the majority of the cases, because only six out of 39 had an adequate level of hemostasis without the use of either ferric sulfate or epinephrine pellets. The surgical technique and choice of anesthetic varied among the operators. The type and amount of epinephrine-containing anesthetic were not standardized. Both methods achieved the desired result of the root-end preparation being dry during the filling procedure, except during one case using ferric sulfate. It is our subjective impression, however, that the epinephrine pellets more consistently achieved better hemostasis than the use of ferric sulfate. In one-third of the cases where ferric sulfate was used, some oozing of blood occurred in the bony crypt, requiring suctioning to maintain dryness of the root-end preparation. This occurred in only one instance when the epinephrine pellets were used. This subjective impression agrees with the opinion of Kim et al. (13). Neither technique is without drawbacks. Use of epinephrine-impregnated cotton pellets has the potential to leave cotton fibers in the surgical site, which could produce inflammation. As stated above, ferric sulfate will produce postoperative inflammation and delayed healing if it is not removed. Further investigation is indicated to find hemostatic agents without these drawbacks.

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