

# Regenerative Endodontic Procedures among Endodontists: A Web-based Survey

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## Abstract

**Introduction:** The protocols that endodontists implement for regenerative endodontic procedures (REPs) are unknown. The aim of this study was to examine current REP protocols among practicing endodontists in the United States. **Methods:** A Web-based survey was sent to 4060 active members of the American Association of Endodontists (AAE). A total of 850 participants completed the survey, representing a 20.9% response rate. **Results:** Responses indicated 60% reported having performed REPs; most performed 1 to 3 per year. The most commonly selected source (60.8%) for the clinical protocol was the "AAE Clinical Considerations for a Regenerative Procedure." Time constraints were the most common reason why 92.4% of respondents did not report their REP cases to the [AAE.org](http://AAE.org) database; additionally, 15.5% were unaware of it. Almost half (49.8%) of the participants reported they would attempt an REP on a patient of any age. The most commonly used irrigants were >3% sodium hypochlorite at the first appointment and EDTA at the scaffold formation appointment. As the intracanal medicament, 52.2% used calcium hydroxide, whereas 23.5% used triple antibiotic paste. At the scaffold formation appointment, 77.1% used a local anesthetic without a vasoconstrictor, and 94.3% used a blood clot as the scaffold. Mineral trioxide aggregate was the coronal barrier most often selected. Considering factors most likely to encourage the use of REPs in the future, 79.8% reported the availability of good candidates followed by 40.1% who desired better evidence. **Conclusions:** Based on the results of this survey, REP protocols appear to be heterogeneous and do not strictly conform to the "AAE Clinical Considerations for a Regenerative Procedure." (*J Endod* 2017; ■:1–6)

## Key Words

Regenerative endodontics, regenerative endodontic procedures, revascularization

Regenerative endodontics is a paradigm shift (1). Although conventional endodontic treatment involves removing diseased pulpal contents to prevent or heal apical periodontitis, regenerative endodontic procedures (REPs) are biologically based procedures designed to replace damaged structures, including dentin and root structures as well as cells of the pulp-dentin complex (2). The continued development of immature necrotic teeth with thin dentinal walls and open apices is critical in order to prevent nonrestorable tooth fractures. Calcium hydroxide (Ca[OH]<sub>2</sub>) apexification procedures and mineral trioxide aggregate (MTA) apical barrier techniques have little root development potential, but REPs have been shown to significantly increase the development of root width and length (3, 4). More importantly, REPs can achieve resolution of apical periodontitis (5), the primary goal of REPs (6).

Published REP cases showed successful outcomes despite the absence of a standardized treatment protocol. The cases are diverse in the etiology of treated disease, chemomechanical debridement regimen, number of visits, and intracanal (IC) medication (5). It is unclear which protocols might lead to a more consistently predictable outcome (7).

Guidelines for REPs have been proposed based on the best currently available evidence (5, 8, 9), in particular, a continuously updated clinical protocol (6). Aside from cases submitted to the American Association of Endodontists (AAE) clinical cases registry, it is unknown whether practicing endodontists are implementing these recommendations. Despite the lack of higher levels of evidence such as randomized controlled trials (9) and the little information available regarding the clinical protocols in failed REP cases (10, 11), the use of guidelines such as the "AAE Clinical Considerations for a Regenerative Procedure" (6) might help maximize successful outcomes.

A survey would give insight into the clinical protocols that practicing endodontists implement. Few surveys have been conducted regarding REPs, and they were limited in the type and number of endodontists surveyed as well as the clinical questions asked (12, 13). The aim of this study was to examine current REP protocols among endodontists in the United States.

## Significance

The AAE provides a continuously updated clinical protocol for regenerative endodontic procedures. It is unknown whether practicing endodontists are implementing these recommendations. This study aimed to gain an insight into the clinical protocols of practicing endodontists in the United States. A Web-based survey was formulated and sent to active members of the AAE.

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## Materials and Methods

In August 2015, a 19-question survey (Table 1) was formulated and delivered via [QuestionPro.com](http://QuestionPro.com) to 4060 members of the AAE in the United States. Members designated as “active” in the online membership directory were selected. Respondents were informed that the survey was a resident research project and that individual responses would be kept confidential.

Questions of the survey included multiple choice, multiple selections, and write-in answers. Respondents who indicated that they had performed REPs (question 3) were taken through the entire survey. For those who did not perform REPs, the survey skipped to question 18. A total of 3 reminder e-mails were sent, and the survey was closed after 4 weeks. All responses were recorded on the [Questionpro.com](http://Questionpro.com) website. Survey results were analyzed and are presented as percentages.

## Results

A total of 850 participants completed the survey, representing a response rate of 20.9%. Among these individuals, the breakdown of years since residency was as follows: 0 to 5 years (30.9%,  $n = 263$ ), 6 to 10 years (13.6%,  $n = 116$ ), 11 to 15 years (14.6%,  $n = 124$ ), 16 to 20 years (11.1%,  $n = 94$ ), and over 20 years (29.8%,  $n = 253$ ). Diplomates of the American Board of Endodontics comprised 31.4% ( $n = 160$ ) of the respondents.

When asked about primary practice setting, 79.8% ( $n = 678$ ) reported being in private practice, 10.2% ( $n = 87$ ) were in academia, 3.1% ( $n = 26$ ) were in federal positions, and 6.9% ( $n = 59$ ) self-identified as residents. The majority (60%,  $n = 510$ ) indicated having performed REPs in their practice with the number of REPs typically performed per year as follows: 1 to 3 (76.9%,  $n = 392$ ), 4 to 10 (19.0%,  $n = 97$ ), 11 to 20 (3.1%,  $n = 16$ ), and greater than 20 (0.6%,  $n = 3$ ).

The great majority (92.4%,  $n = 471$ ) indicated not reporting their cases to the AAE's online database for REPs, and the reasons included time constraints (47.3%,  $n = 241$ ), being unaware of the database (15.5%,  $n = 79$ ), and case failure (3.5%,  $n = 18$ ). The remainder gave various other responses (25.7%,  $n = 131$ ) or no response (8%,  $n = 41$ ).

There was an even split on whether there is an age at which a regeneration procedure would no longer be attempted; 49.8% ( $n = 254$ ) selected yes, and 49.8% ( $n = 254$ ) chose no. A blank was given by 2 respondents (0.4%). The ages at which regeneration procedures would no longer be attempted were <10 years (1.2%,  $n = 3$ ), 10–15 years (21.3%,  $n = 54$ ), 16–20 years (34.6%,  $n = 88$ ), 21–29 years (8.7%,  $n = 22$ ), 30–39 years (7.1%,  $n = 18$ ), 40–49 years (3.9%,  $n = 10$ ), and >50 years (2.4%,  $n = 6$ ). Other various criteria were given by 20.5% ( $n = 52$ ) of the respondents.

Irrigants used at the first appointment were >3% sodium hypochlorite (NaOCl) (36.7%,  $n = 187$ ), EDTA (29.2%,  $n = 149$ ), 1.5% NaOCl (23.7%,  $n = 121$ ), 1.6%–3.0% NaOCl (22.7%,  $n = 116$ ), sterile saline (12.5%,  $n = 64$ ), 2% chlorhexidine (11.2%,  $n = 57$ ), <1.5% NaOCl (9.6%,  $n = 49$ ), sterile water (6.5%,  $n = 33$ ), and 0.12% chlorhexidine (6.1%,  $n = 31$ ).

Most (70.2%,  $n = 358$ ) reported that they do not mechanically instrument the dentinal walls, and 29.6% ( $n = 151$ ) indicated that they do. Ca(OH)<sub>2</sub> was the most commonly used IC medicament (52.2%,  $n = 266$ ) (Fig. 1).

Two treatment visits were required by 77.1% ( $n = 393$ ) of the participants, >2 by 20.0% ( $n = 102$ ), 1.4% ( $n = 7$ ) by those who selected 1 appointment, and 1.4% ( $n = 7$ ) who gave a response of “other.” As for the reasons of why more than 2 visits were required, the responses were highly variable.

The majority (37.6%,  $n = 192$ ) reported bringing the patient back in at 2 weeks for the second appointment. Others reported 4 weeks (32.5%,  $n = 166$ ), 3 weeks (18.2%,  $n = 93$ ), 1 week (7.3%,  $n = 37$ ), and >5 weeks (3.9%,  $n = 20$ ). If there were signs/symptoms of persistent infection, 63.7% ( $n = 325$ ) would reapply the same IC medicament and follow-up. A different IC medicament would be applied by 17.5% ( $n = 89$ ), and 12.2% ( $n = 62$ ) would cease the REP. Various other responses were given by 6.3% ( $n = 32$ ). The selection of a local anesthetic without a vasoconstrictor at the scaffold formation appointment was reported by 77.1% ( $n = 393$ ), and 22.7% ( $n = 116$ ) would opt for a local anesthetic containing a vasoconstrictor.

At the second (scaffold formation) appointment, the irrigants used were EDTA (57.1%,  $n = 291$ ), sterile saline (20.6%,  $n = 105$ ), >3.0% NaOCl (17.8%,  $n = 91$ ), 1.6%–3.0% NaOCl (13.3%,  $n = 68$ ), sterile water (11.4%,  $n = 58$ ), 2% chlorhexidine (10.6%,  $n = 54$ ), 1.5% NaOCl (9.4%,  $n = 48$ ), <1.5% NaOCl (5.7%,  $n = 29$ ), and 0.12% chlorhexidine (4.9%,  $n = 25$ ). Most respondents induced bleeding (94.3%,  $n = 481$ ) for scaffold formation. Just 1.6% ( $n = 8$ ) reported using platelet-rich fibrin, and 1.0% ( $n = 5$ ) used platelet-rich plasma. Various other responses were given by 2.7% ( $n = 14$ ).

The coronal barrier of choice was MTA for 78.4% ( $n = 400$ ) of the participants. Others reported using EndoSequence Root Repair Material (Brasseler, Savannah, GA) (ERRM) (14.1%,  $n = 72$ ), Biodentine (Septodont, Saint-Maur-des-Fossés, France) (5.3%,  $n = 27$ ), glass ionomer (2.2%,  $n = 11$ ), and various other materials (3.5%,  $n = 18$ ).

The “AAE Clinical Considerations for a Regenerative Procedure” was the most commonly selected source for a clinical protocol for REPs (60.8%,  $n = 310$ ) (Fig. 2). When asked about which factor would likely encourage the use of REPs in the future, the availability of good candidates was the most cited response (79.8%,  $n = 678$ ) followed by better evidence (40.1%,  $n = 341$ ) (Fig. 3).

## Discussion

Since the groundbreaking case reports in REPs by Banchs and Trope (14) and Iwaya et al (15), many others have shown the resolution of periapical radiolucencies and continued root development (5). However, the lack of higher levels of evidence (16) and the absence of a standardized protocol (10) can preclude the optimization of consistently successful outcomes. Fortunately, the AAE provides a continuously updated source of information for REPs based on the best available evidence (6). Although the protocols of published studies have been examined (5, 10), those protocols of practicing endodontists were unknown until now. Our study indicates REP protocols of practicing endodontists in the United States appear to be heterogeneous and do not strictly conform to the “AAE Clinical Considerations for a Regenerative Procedure.”

A recent survey (17) reported a lower percentage (49.9%) of respondents having performed REPs compared with what was found in our study (60%). This may suggest that REPs continue to gain acceptance among practicing endodontists. However, most (76.9%) reported performing just 1 to 3 procedures per year. This could be related to reasons such as the lack of availability of good candidates for REPs (79.8%) and the lack of higher levels of evidence (40.1%).

The AAE website has an online database in which REPs cases can be submitted. However, 92.4% reported that they do not submit their cases to the database. The majority of those who do not submit (47.3%) cited time constraints, and a sizable proportion of respondents (15.5%) indicated that they were unaware of such a database.

The even split among respondents regarding the age at which a regenerative procedure would no longer be attempted suggests REPs are being attempted in an older demographic. This differs from that

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