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Regenerative endodontic procedure using Emdogain: a case series

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Abstract

Background Emdogain (Straumann® Emdogain®, Basel, Switzerland) is an enamel matrix derivative and has an important role in odontogenesis, by potentializing pulp tissue repair and regeneration, as showed in biological studies. Nevertheless, the benefits of using Emdogain as a scaffold in clinical regenerative endodontic procedures has not been demonstrated and is not yet fully understood. The aim of this report was to show three clinical cases that had different preoperative conditions and underwent pulp regenerative procedures under an identical clinical protocol. This report also aimed to show the value of using Emdogain to guide angiogenesis and the healing process by reporting clinical and radiographical results. This is a pioneering study on the use of Emdogain in regenerative endodontic procedures in humans.

Cases presentation This report is a retrospective description of clinical findings from three regenerative treatments conducted under an identical protocol in two appointments using Emdogain as a scaffold. The three young Brazilian patients, aged 8, 8, and 12 years old (one female and two male), are from São Luís city, state of Maranhão. All three patients identify as Pardo ethnicity with brown skin color, come from low-income backgrounds, and had necrotic immature permanent teeth. Quantitative assessments of crown shades of treated teeth were determined with VITA Easyshade® Advance 4.0 spectrophotometer (VITA Zahnfabrik, Bad Sackingen, Germany) at baseline to 24-month follow-up. Self-reported pain was measured using the visual analogue scale (VAS) at the time of treatment (shortly after induction of bleeding into the canal) and at 7 day following the procedure. At 12 months, radiographic lesions were resolved. At 24 months there were apical closures, and the three teeth remained in function without symptomatology or signs of failure. All cases had the root length increased and the dentin wall thickened. One case presented radiographic images suggestive of scattered calcified zones in the root canal lumen.

Conclusion Emdogain may be beneficial as a scaffold in regenerative endodontic procedures. The following outcomes were noted at 24-month follow-up: continuity of root formation, thickening of the root dentin walls, and closure of the root apex.

Keywords Regenerative endodontics, Dental pulp necrosis, Enamel matrix derivative, Odontogenesis

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Background

The prognosis for teeth that underwent pulp regenerative procedures depends on a variety of factors, including pre-, intra-, and postoperative variables. Although every factor may play an important role in the therapy outcome, in several cases, the clinical and radiographic results may be unpredictable.

Regenerative endodontic (or pulp revascularization) was suggested in 2004 as an alternative therapy to treat permanent immature (incomplete rhizogenesis) necrotic teeth [3]. Pulp regeneration consists of cleaning the root canal (no shaping or very gentle shaping) and inducing a blood clot that should originate from the periapical area and fill the canal space [3, 14]. The blood clot would serve then as a matrix to help the formation of new vital tissue—this occurs because it brings important cells coming from the apical region, responsible for tooth formation: the epithelial sheath of Hertwig (that normally would be available only until the complete root formation) [21]. The presence of cells from the apical papilla will contribute to finalizing the root development upon thickening the dentinal walls, increasing in root length, and ultimately, restoring the pulp vitality of those nonvital/necrotic teeth [2, 44].

Protocols for regenerative endodontic procedures vary in terms of the use of irrigating solutions [11, 34, 39], intracanal medication [3, 10, 17], scaffolds [24, 46], and materials for cervical sealing [10, 15, 31, 39]. Authors have stated that the predictability of outcomes in regenerative procedures depends on the eradication of infection [12], the source and duration of apical periodontitis (periapical lesion), or the severity of injury that the apical papilla and the stem cells (epithelial sheath of Hertwig) have undergone [8]. However, it is impossible to know the conditions of these factors in clinical practice; consequently, therapy outcomes are unpredictable.

A blood clot has been the main scaffold in the published case studies [6, 7, 9, 15, 18, 34, 39]. However, it would be advantageous if regenerative strategies using advanced scaffolds and growth factors could favor pulp and dentine regeneration. Several biomaterials have been investigated using animal models, such as alginate, hyaluronic acid, chitosan, PLLA NF-MS(Poly(L-lactic acid) Nanofiber Microspheres) with BMP-2 (Bone Morphogenetic Protein-2), PLGA-PEG (Poly(lacticco-glycolic acid)-Polyethylene Glycol) nanoparticles, and Vitrogel 3D with SDF-1a (Stromal Cell-Derived Factor 1 alpha) and BMP-2 [35].

It is well documented that the secretion of enamel matrix-derived proteins by Hertwig's epithelial sheath triggers a cascade of reactions that stimulate odontogenesis [22, 42]. The enamel matrix derivative is commercially available as Emdogain (EMD, Straumann® Emdogain®, Basel, Switzerland) and is well recognized in periodontics for its regenerative potential [22]. In the conservative treatment of the pulp, EMD induces the formation of reparative dentin, protecting the pulp tissue from inflammation and degeneration [13, 29, 32]. In 2012, authors demonstrated that EMD, when used as an intracanal medication, was able to promote root development in rat teeth, similar to the triple antibiotic paste, which is the original intracanal medication indicated for regenerative therapy [38]. Another study evaluated the effects of EMD on the proliferation and differentiation of human dental pulp cells (hDPCs) *in vitro*. They concluded that EMD could enhance the mineralization of hDPCs and increased the expression of markers for odontoblast/osteoblast-like cells [45]. EMD has demonstrated recognized high biocompatibility and significant wound healing potential, as highlighted by Munar-Bestard *et al.* [25], who reported its favorable regenerative capacity and biocompatibility in comparison with other commercial periodontal gels. Nevertheless, EMD potential in regenerative endodontics is not yet fully understood, although it has shown an important role in odontogenesis, with potentiation of pulp tissue repair and regeneration [45].

The aim of this cases series was to present three clinical cases that had different preoperative conditions (such as, patient's age, pulp/periapical diagnosis, and tooth type) and who underwent pulp regenerative procedures under an identical clinical protocol. In addition, this report also aimed to show the value of using EMD as a scaffold to guide angiogenesis and the healing process by reporting clinical and radiographical results.

Cases presentation

Study design and ethics

This report is a retrospective description of clinical findings from three regenerative treatments that were conducted under the same technique/protocol. The material used in the root canals as a scaffold was Emdogain (EMD, Straumann® Emdogain®, Basel, Switzerland), a gel formulation commercialized in a plastic syringe containing enamel matrix derivative. Patients' parents signed an informed consent. Use of patient's information to construct this article was approved by the Research Ethics Committee at the university/dental school where the treatments took place (approval no.: #2.997.609). This report was written according to Preferred Reporting Items for Case reports in Endodontics (PRICE) 2020 guidelines [27, 28].

Setting, patients, crown shades, and self-reported pain assessments

From October 2018 to February 2022, a total of three young patients (ages 8, 8, and 12 years old; all with brown skin color and Pardo ethnicity; one female and two male; and from low-income backgrounds with necrotic immature permanent teeth (mandibular molar, maxillary central incisor, and maxillary central incisor) underwent regenerative procedures performed in two appointments (with 2-week intervals in between sessions) at the dental

school clinic. Medical history, dental history, and dental examination (including radiographs, periodontal evaluation, and pulp-periapical tests) were obtained before proceeding with the treatment. Patients were recalled at 3, 6, 12, 18, and 24 months for follow-up.

Quantitative assessments of crown shades of treated teeth were determined using the VITA Easyshade® Advance 4.0 spectrophotometer (VITA Zahnfabrik, Bad Sackingen, Germany) at baseline (before treatment), immediately after the completion of the treatment, and at each follow-up session.

Self-reported pain was measured using the visual analogue scale (VAS) with degrees numbered from 0 (no pain) to 10 (worst possible pain) at the time of treatment (shortly after induction of bleeding into the canal) and at 7 days following the procedure. The dental assistant helped the patient to point out a degree of pain in the VAS, since the patient was under rubber dam isolation.

Clinical procedure: regenerative treatment

The same regenerative treatment protocol was conducted by two operators/dentists in the three clinical cases.

In the first session, the dentist applied local anesthesia with 4% articaine 1:100,000 epinephrine (Nova DFL, Rio de Janeiro, Brazil), and rubber dam isolation with a single hole (in the tooth to be treated). Pulp chamber access opening was then performed to allow irrigation with 10 mL 2.5% sodium hypochlorite (NaOCl—Fórmula e Ação, São Paulo, Brazil) using 27-G irrigating tips (Ultradent Products Inc. South Jordan, Utah, USA). The working length was radiographically determined using stainless-steel K-files [the biggest size that could be gently fitted into the root canal(s)]. A gentle mechanical preparation (K-files) was performed in the coronal and middle third of the canals. Each canal was then irrigated with 10 mL 2.5% NaOCl and 10 mL ethylene diamine tetra acetic (EDTA) acid (Fórmula e Ação, São Paulo, Brazil). Final irrigation was performed with additional 10 mL 2.5% NaOCl, and 10 mL saline solution. Canals were dried with sterile paper points and medicated with calcium hydroxide (Ultracal—Ultradent, EUA). The access cavity was double sealed with sterile cotton pellet, temporary filling material (Coltosol®, Coltene, Rio de Janeiro, RJ, Brazil), and restorative glass ionomer cement Riva Light Cure (SDI, Victoria, Australia).

In the second session, the dentist applied a local anesthetic infusion without vasoconstrictor (2% lidocaine, Nova DFL, Rio de Janeiro, Brazil). Root canals were accessed and irrigated with 10 mL EDTA to remove calcium hydroxide, followed by a final rinse with 10 mL of saline solution. Canals were then dried with sterile paper points. Bleeding was generated by gently disrupting (upon shorter quarter-turn movements) periapical tissues 2 mm beyond the root apex with a size #40 K-file. Upon observing the initial outflow of blood in the root canal(s), the dentist inserted EMD (Emdogain® Institut Straumann AG, Basel, Switzerland), injecting it directly from the syringe and using the full amount of the medication (0.15 mL). In the subsequent minutes, a suitable blood clot (mixed with EMD) had formed. Therefore, approximately 2 mm thickness of white mineral trioxide aggregate (MTA; MTA Angelus, Londrina, Paraná, Brazil) was gently deposited and condensed in the coronal third of the canal. Restorative glass ionomer cement was placed over the MTA, followed by a composite resin restoration (3 M ESPE, St. Paul, MN). Periapical radiographs confirmed the MTA placement and final restoration.

Table 1 summarizes the technical information and treatment sequence.

Case 1

An 8-year-old female patient was referred to the comprehensive clinic at the dental school because of a facial swelling on the left side and fever. The person responsible for the child reported painful symptoms that had started 2 days prior. Medical history was noncontributory. Intraoral examination found edema around the apical region of tooth #3.6 (left mandibular first molar). Probing depths were within the normal limits. The tooth was nonresponsive to cold test and electrical pulp test (EPT), and positive for periapical palpation and vertical percussion (tenderness). The tooth crown was shade A2. The pulp chamber had been previously accessed and the tooth had a provisional restoration, however, carious tissue was still present (visualized clinically and radiographically). Periapical radiograph showed open apices in the mesial and distal roots and a periapical radiolucency at the distal root (Fig. 1A). Diagnosis for tooth #3.6 was pulp necrosis and acute apical abscess. The regenerative endodontic procedure was accepted by the patient's guardian, and it was performed according to protocol (Table 1). The patient pointed at the worst pain possible (10 at VAS) during the induction of bleeding transoperatively. Bleeding time duration was 60 seconds. No pain occurred in the following week and at 7-day follow-up (0 at VAS). At 3-month follow-up the patient was asymptomatic (all clinical tests were within the normal limits). Radiograph showed that the periapical region had healed (Fig. 1B). At 6-month and 12-month follow-ups the patient remained asymptomatic (palpation and percussion negative), but with a positive/normal response for cold and EPT. Radiograph showed normal periodontal ligament and an increase in root length and width for tooth #3.6 (Fig. 1C and D). At 24-month follow-up the patient was still asymptomatic, and the tooth was responding to thermal

Table 1 Technical information and treatment sequence for the three regenerative endodontic cases reported in this article

	Protocol	
Sequence	**First appointment**	**Second appointment (2 weeks later)**
1	Local anesthesia 4% articaine 1:100,000 epinephrine	Local anesthesia 2% lidocaine without vasoconstrictor
2	Rubber dam isolation and access opening	Rubber dam isolation and re-access opening
3	Irrigation with 10 mL 2.5% sodium hypochlorite (NaOCl)	Irrigation with 10 mL EDTA to remove the calcium hydroxide (Ultracal®)
4	Working length (periapical radiography) and gentle mechanical preparation in the coronal and middle canal thirds	Irrigation with 10 mL saline solution
5	Re-irrigation with 10 mL 2.5% NaOCl with 27-G needle tip	Drying with absorbent paper points
6	Irrigation with 10 mL EDTA	Bleeding induction with K-file size #40, gentle movements up to 2 mm beyond the root apex
7	Irrigation with 10 mL of 2.5% NaOCl	Determination of bleeding time (s)
8	Irrigation with 10 mL of saline	Application of the total syringe (0.15 mL) of EMD (Emdogain®) mixing with blood
9	Drying with absorbent paper points	Placement and condensation of white MTA in the coronal third of root canals
10	Insertion of calcium hydroxide (Ultracal®)	Base of restorative glass ionomer cement
11	Insertion of a sterile cotton pellet	Definitive restoration with composite resin
12	Temporary restoration (Coltosol® + Riva Light Cure restorative glass ionomer cement)	Radiograph to confirm MTA placement/adaptation

and electrical tests. The color of the crown was shade A3. The apex of the mesial root was closed, and the periodontal ligament was within the normal limits (Fig. 1E).

Case 2

An 8-year-old male patient was referred to the comprehensive clinic at the dental school because of a tooth fracture. The person responsible for the child reported that a trauma in the mouth had occurred at the school 15 days prior. Medical history was noncontributory. Intraoral examination found an uncomplicated crown fracture (involving enamel and dentin) in tooth #1.1 (right maxillary central incisor). Probing depths were within the normal limits. The tooth was nonresponsive to cold test and electrical pulp test (EPT), and negative for periapical palpation and vertical percussion. The tooth crown was shade B2. Periapical radiograph showed open apex and no periapical radiolucency (Fig. 2A). Diagnosis for tooth #1.1 was pulp necrosis with normal apical tissues. The regenerative endodontic procedure was accepted by the patient's guardian, and it was performed according to protocol (Table 1). The patient pointed at severe pain (8 at VAS) during the induction of bleeding transoperatively. Bleeding time duration was 50 seconds. At 7-day follow-up no pain was reported for the day and the week before (0 at VAS). The tooth was then restored with composite resin. At 3-month follow-up the patient was asymptomatic and the tooth unresponsive to thermal and electrical tests. The color of the crown became darker (shade C3). Radiographic examination showed continuity of root length formation and a radiopaque image in coronal third of the canal, suggestive of hard tissue formation (Fig. 2B). At 6-month follow-up the patient remained asymptomatic, and the tooth was unresponsive for pulp tests. The color of the crown became darker (shade C4). Root length formation and the radiopaque image in coronal third of the canal were more evident (Fig. 2C). At 12-month follow-up the tooth was now

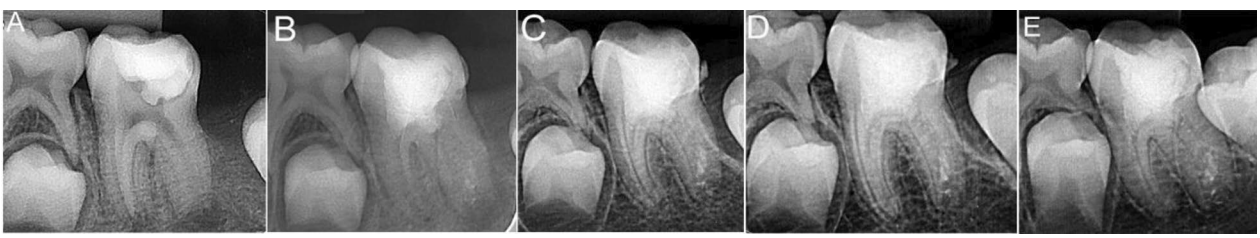

Fig. 1 Case 1: tooth #3.6. **A** Preoperative periapical radiograph (PA). **B** PA at 3 months following the regenerative endodontic procedure with Emdogain as scaffold. **C** PA at 6-month follow-up showing the continuity of root length formation. **D** PA at 12-month follow-up, showing the complete absence of a periapical lesion. **E** PA at 24-month follow-up, with closure of root apex

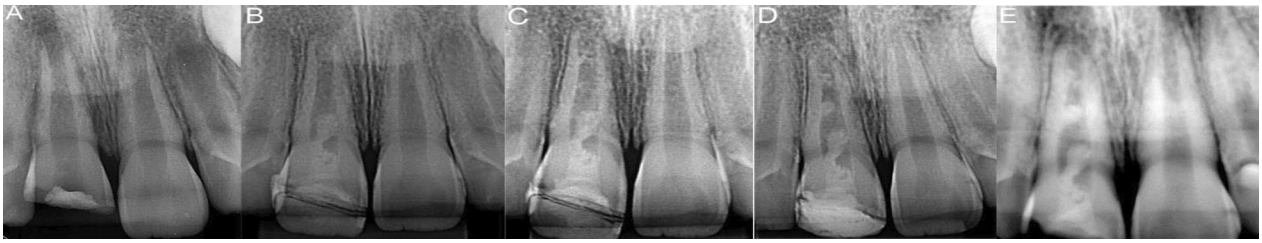

Fig. 2 Case 2: tooth #1.1. **A** Preoperative periapical radiograph (PA). **B** PA at 3 months following the regenerative endodontic procedure with Emdogain as scaffold. **C** PA at 6-month follow-up showing continuity of root length formation and appearance of radiopaque images (suggestive images of calcified material) within the root canal. **D** and **E** PA taken at 12 and 24 months, respectively, showing radiopaque images, dentinal thickening, and apical closure

responding positive/normal to pulp tests, but the color of crown remained shade C4 (Fig. 2D). At 24-month follow-up the clinical signs remained unchanged. The root apex had closed, and the periodontal ligament was normal (Fig. 2E).

Case 3

A 12-year-old male patient was referred to the comprehensive clinic at the dental school for restorative treatment. The person responsible for the child reported that a trauma in the mouth had occurred more than a year ago. Medical history was noncontributory. Intraoral examination found a provisional restoration on tooth #2.1 (left maxillary central incisor) and crown discoloration (shade A3). Probing depths were within the normal limits. The tooth crown was shade A3. The tooth was nonresponsive to cold test and electrical pulp test (EPT), and negative for periapical palpation and vertical percussion. Periapical radiograph showed pen apex and a periapical radiolucency (Fig. 3A). Diagnosis for tooth #2.1 was pulp necrosis and asymptomatic apical periodontitis. The regenerative endodontic procedure was accepted by the patient's guardian, and it was performed according to protocol (Table 1). The patient pointed at severe pain (8 at VAS) during the induction of bleeding transoperatively. Bleeding time duration was 27 seconds. At 7-day follow-up no pain was reported for the day and the week before (0 at VAS). At 3-month follow-up the patient was asymptomatic and the tooth was unresponsive to thermal and electrical tests. The color of the crown had changed to shade C3. At 6-month follow-up the patient remained asymptomatic, and the tooth was unresponsive to pulp tests. The tooth color continued to be C3. Radiographic examination showed continuity of root length formation and a potential closure of the apex (Fig. 3C). At 18-month follow-up tooth remained unresponsive to pulp tests, but the color was at this time shade B3. There was continuity of root formation, slight apical closure, periodontal ligament normal, and periapical healing (Fig. 3D).

Table 2 presents some of the pre-, trans-, and postoperative factors for each one of the reported cases.

Discussion and conclusion

Several factors that can affect clinical outcomes of regenerative procedures were pointed out in the document from the American Association of Endodontists (AAE) titled "Clinical Considerations for a Regenerative Procedure" (AAE 2018), and the goals were classified as: primary (the resolution of signs and symptoms of infection), secondary (further root maturation is desirable),

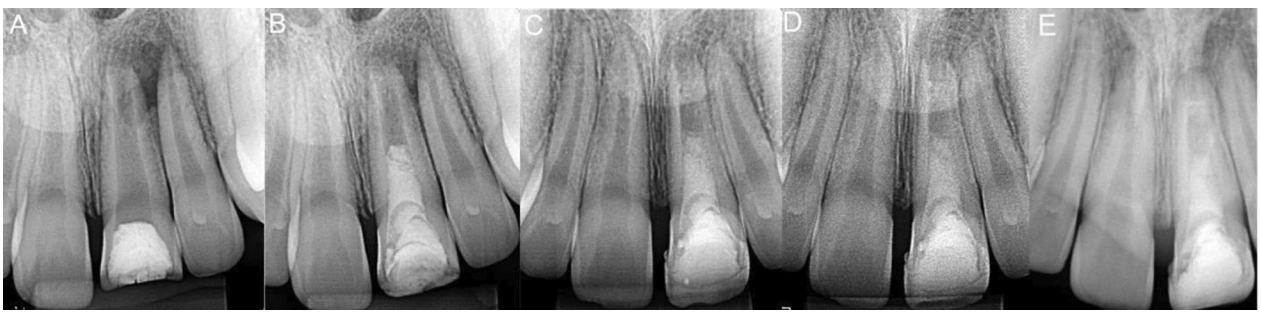

Fig. 3 Case 3: tooth #2.1. **A** Preoperative periapical radiograph (PA). **B** PA at 3 months following the regenerative endodontic procedure with Emdogain as scaffold. **C** PA at 6-month follow-up showing mild root thickening. **D** and **E** PA at 12- and 24-month follow-ups, respectively, showing mild root thickening, tendency to close the root apex, and regression of the periapical lesion

Table 2 Pre-, trans-, and postoperative factors for each one of the reported cases of regenerative therapy. All cases were followed up to 24 months

	Patient age	Gender	Tooth	Diagnosis	Bleeding time (seconds)	Intraoperative pain (VAS)	Radiolucency resolution	Tooth discoloration baseline > end	EPT follow-up at 3/6/12/24 months	Cold test follow-up at 3/6/12/24 months	Root thickening	Root lengthening	Apical closure
Case 1	8	Female	3.6	Pulp necrosis, acute apical abscess	60	10	Yes	A2 > A3	–/+/+/+	–/+/+/+	–/+/+/+	–/–/+/+	–/–/–/+
Case 2	8	Female	1.1	Pulp necrosis, normal apical tissues	50	8	N/A	B2 > C4	–/–/–/+	–/–/±	–/–/+/+	–/–/–/+	–/–/+/+
Case 3	12	Male	2.1	Pulp necrosis, asymptomatic apical periodontitis	27	9	Yes	A3 > B3	–/–/+/+	–/–/–/–	–/–/–/+	–/–/+/+	–/–/–/+

VAS visual analogue scale, *N/A* not applicable, *EPT* electrical pulp test

and tertiary (return of neurogenesis). After regenerative endodontic procedures in nonvital immature teeth, a 20% increase in root canal wall is usually required to produce a significant clinical effect (strengthening of tooth structure). For this, little or no instrumentation is indicated [37].

In the present case series, all cases had dentinal thickening and a tendency to close the apex. In addition, radiopaque deposits were observed in the root canal. Two cases had positive responses to pulp sensitivity tests at different moments (case 1 from 6-month to 24-month follow-up and case 2 at 12-month follow-up). Patients from the reported case 2 and case 3 had a history of dental trauma. All teeth showed resolution of signs and symptom.

The literature has showed some cases with suboptimal clinical results, such as absence of increase in root length [31, 34], absence of increase in root wall thickness [7, 34], or lack of formation of tooth apex, and formation of a hard-tissue barrier inside the canal between the coronal MTA plug and the root apex [7]. In this study, none of the three reported cases had a complete obliteration with hard tissue in the root canal at 24-month follow-up. However, it is important to bear in mind that this unwanted outcome can have long-term results.

It has also been speculated that there would be a relationship between the duration of pulp necrosis and the outcome of the treatment [31]. In this line, we showed in this report that case 2 had radiopaque images inside the root canal, suggestive of calcified tissue, which therefore could be a correlation between dental history and quality of root development because of the longer duration of pulp necrosis.

Lack of continued root development following regenerative endodontic procedures is likely due to severe damage to the stem cells, because they regulate the root development. If the apical papilla is severely damaged, there will be no newly differentiated odontoblasts to produce root dentine. However, the survival of the apical papilla, Hertwig's epitelial root sheath, and dental follicle in immature permanent teeth with pulpal infection or dental trauma is not under the full control of the clinician. It is interesting that some previous studies have shown sufficient root development, but at the same time, the tooth was unresponsive to pulp tests. This may happen because, as such histological examinations have proven, regeneration may have happened upon the formation of periodontal- and bone-like tissues rather than a pulp–dentine complex [4, 19, 23, 30, 40, 41, 43].

Intra- and postoperative pain were assessed in this case series (through VAS scales). Pain is a relevant factor for patients and can impact the dental procedure, as well as patients' quality of life. Pain during the dental procedure, especially in children and adolescents, is challenging for the dentist, sometimes impairing the continuation of the treatment. Patients' quality of life can reduce as a consequent of pain, impairing speech, chewing, and social and psychological aspects (for instance, difficulty relaxing and irritability) [20, 33]. This report showed that the three patients had pain during the procedure (at the time of bleeding induction) ranging from 1 (mild pain) to 10 (worst possible pain). Using local anesthetics without vasoconstrictors is recommended to facilitate bleeding after root canal disinfection [34]; however, alternatives to pain mitigation should be sought at this stage, as patient collaboration is essential for a technically appropriate clinical procedure. Conversely, postoperatively there was no manifestation of pain in our three patients. Awareness of the negative impacts felt by the patient—either in intra- or postoperative phases—is important for taking precautions in future treatments for the same patient.

The three patients presented tooth discoloration after 24 months following the regenerative procedure. Studies reported a percentage ranging from 44% to 83% of coronal discoloration [26, 36]. The mechanism of discoloration is most evident when tetracycline-based antibiotics (minocycline or doxycycline) were used as intracanal medication. In the present report, even with the choice of using calcium hydroxide as medication, we noticed considerable crown discoloration. In addition, mineral trioxide aggregate (MTA), which was used over the blood clot at the coronal third of the root canals, may also have played a role in making the teeth darker [1, 7, 16]. Authors have shown that using MTA as a pulp capping material had caused considerable discoloration [5]. In vital pulp therapy (pulp capping and pulpotomy), it is assumed that the chances of discoloration are greater because the material is placed at the crown level and not at the root level (as in regenerative procedures).

One challenge concerning the cases reported here was that of maintaining the bioceramic material (MTA) in the coronal third of larger root canals without it leaking to the rest of the canal. Our case 3 exemplifies this difficulty, since the radiographs show some material beyond the coronal third. This case series is strong because it is the first to be published using EMD as scaffold for regenerative procedures. Although case reports do not provide definitive evidence to support the treatment protocol, they have the advantage of being performed in real patients and may provide future guidelines for other study designs.

This report showed that EMD may be beneficial as a scaffold in regenerative endodontic procedures. The following outcomes were noted at 24-month follow-up: continuity of root formation, thickening of the root dentin walls, and closure of the root apex.

Abbreviations

EMD	Emdogain
VAS	Visual analogue scale
PRICE	Preferred reporting items for case reports in endodontics
EDTA	Ethylene diamine tetra acetic acid
MTA	Mineral trioxide aggregate
AAE	American Association of Endodontists

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Author contributions
Conceptualization: CNC and KLMS; methodology: KLMS, LGD, and CCRM; validation: MCF and GRS; formal analysis: CNC and RGS; investigation: KLMS; resources: CNC; data curation: MCF; writing—original draft preparation: KLMS, LGD, and CNC; writing—review and editing: MCF and RGS; supervision: CNC; project administration: CNC; and funding acquisition: CNC. All authors have read and agreed to the published version of the manuscript.

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Availability of data and materials
The datasets used and analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
All methods were carried out in accordance with relevant guidelines and regulations and performed in accordance with the Declaration of Helsinki. Patients' parents signed an informed consent. Using of patient's information to construct this article was approved by the Research Ethics Committee at the university school where the treatments took place (approval no.: #2.997.609).

Consent to publication
Written informed consent was obtained from the patients' legal guardians for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
The authors deny any conflicts of interest related to this study.

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