Rehabilitative treatment after unsuccessful teeth replantation: a case report

Paulo Floriani Kramer* / Sady Horst** / Joice König*** / Eduardo Galia Reston**** / Ernani Calvete*****

A nine-year-old boy suffered a severe facial trauma in a bicycle crash, which resulted in the avulsion and subluxation of upper central incisors. Teeth were repositioned and stabilized, attempting to achieve a successful replantation. Root resorption occurred, teeth were extracted, followed by orthodontic treatment, and esthetic procedures, modifying laterals and canines.

This article reports an attempt and failure of replantation, providing alternatives for achieving patient's satisfaction, applying a variety of techniques and areas of dental profession.
J Clin Pediatr Dent 26(2): 119-124, 2002

INTRODUCTION

Children are more frequently subjected to trauma, particularly in the facial area. Scientific literature states that there are two different types of facial trauma related to the dental profession: trauma that implicates the hard tissues and trauma that involves the support structures. It is possible to observe both types of injuries occurring at the same time.[1] About 1 to 16% of these injuries result in avulsion, usually between ages varying from 7 to 11,[2] due to the incomplete root development and immaturity of the periodontal ligament (PDL).

Avulsion is the complete displacement of the tooth from its alveolus and the immediate procedure to be accomplished consists of the replantation of the tooth. Several factors may interfere in the success of the replantation, such as: the length of time that the tooth remains out of the alveolus (extra-alveolar period) and the storage media employed. These two factors are directly related to the occurrence of root resorption.[3,4] According to these factors are decisive for healing and revascularization of the damaged PDL, obtaining the reattachment of Sharpey's fibers, followed by the reestablishment of gingival physiology and pulpal revascularization.

Revascularization of the pulp depends on the size of the pulp-periodontal interface, directly related to the development of the root. A great number of successful cases is found in teeth with open apex (incomplete rhizogenesis).[5] The second decisive factor is the bacterial contamination of the pulp, once the presence of microorganisms in the pulp tissues hinders revascularization.[6,7] Andreasen and Andreasen[1] also mentioned the importance of extra-alveolar period shorter than 120 minutes and a favorable storage media for the success of the revascularization.

The success of a replanted tooth seems to have a direct correlation to the length of time the tooth remains out of the alveolus. This can be explained because the PDL suffers a dehydration process, starting a series of pathological changes that culminate with necrosis.[1] Andreasen[4] stated that the PDL should be removed if the extra-alveolar time is more than 120 minutes, except if the tooth is stored in milk, in which a storage time up to 6 hours is accepted. Milk seems to fill the basic storage media requirements, once it creates favorable conditions for the PDL cells, presenting osmolarity and pH compatible to these cells.[8] The use of the water as storage media for avulsed teeth is frequent, however several studies have demonstrated that

* Paulo Floriani Kramer, MSc, PhD, Professor and Head of Pediatric Dentistry Department at Lutheran University of Brazil, Rua Liberdade,42, Porto Alegre – RS 90420-090, Brazil.
e-mail: paulokramer@hotmail.com

** Horst, Private Practioner, Certificate in Orthodontics, Rua Miguel Tostes, 101 Cx. Postal 124 Canoas – RS 92420-280, Brazil.
e-mail: ortosadifh@ig.com.br

*** Joice König, Resident in Pediatric Dentistry Lutheran University of Brazil, Rua Miguel Tostes, 101 Cx. Postal 124 Canoas – RS 92420-280, Brazil.
e-mail: joice.konig@terra.com.br

**** Eduardo Galia Reston, MSD (corresponding author) Professor and Head of Restorative Dentistry – Lutheran University of Brazil, Rua Liberdade, 42 Porto Alegre – RS 90420-090, Brazil.
Phone # 55 51 9117.4111 Fax # 55 51 333.77.33
e-mail: reston@alumni.indiana.edu or reston@via-rs.net

***** Ernani Calvete, Professor of Periodontics Lutheran University of Brazil, Rua Miguel Tostes, 101 Cx. Postal 124 Canoas – RS 92420-280, Brazil.
e-mail: ecalvete@conex.com.br

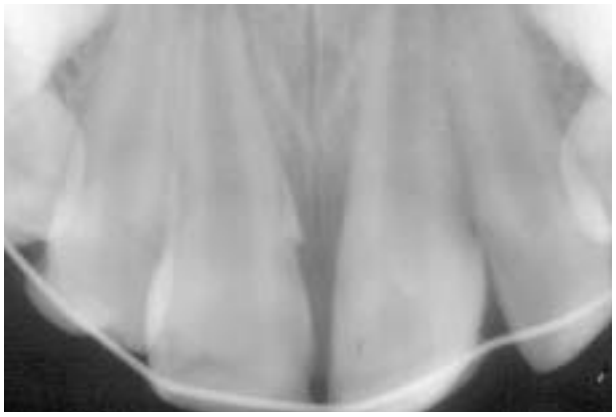

Figure 1. Radiographic image after replantation and fixation. (March - 1993).

Figure 2. Periodic radiographic exam. (March - 1994).

it seems to be the least favorable one, because its hypotonicity leads cells to lysis.[4,9,10]

Saliva is also a frequently available storage media for avulsed teeth. It is not always used due to the psychological aspects involving the patient and the caretaker. There is also a problem of bacterial contamination that is adhered into the PDL, which may act to cause root resorption.[10] Whenever saliva is used as a storage media, root surface must be irrigated thoroughly with a saline solution prior to replantation. Saline solution and saliva do not present any healing properties, acting just maintaining properties of cellular vitality.[11]

Blomlöf *et al.*[8] and Blomlöf[10] verified that the best storage media of the PDL cells are cellular preservation solutions with balanced pH, like Viaspan or Hank's balanced salt solution.

Resorption of different types and severity are observed in those cases of serious physical injury or bacterial contamination of either pulp or PDL. A superficial resorption, a substitutive resorption or an external inflammatory resorption may occur concomitant to the healing process.[12-14]

The superficial resorption is the result of a smaller injury of the PDL, where the root surface is resorbed by macrophages and osteoclastic cells. This process creates a defective surface, which is spontaneously repaired by the cementum deposition. Surface resorption does not consist in a clinical problem and it is difficult to be visualized in radiographs. It is self-limiting, remodeling and does not need treatment.[1,14]

Whenever large areas of the PDL are traumatized or permanently damaged, a healing occurs in a competitive way between the bone medulla derived cells and those cells from the PDL. The result of this competition is an ankylosis, which may progress to a substitutive resorption. This would be characterized by disappearance of the PDL and gradual replacement of dental tissue by osseous tissue.[1] The process is very active in young patients, in which the longevity of the injured tooth can be limited to some years. In adults, resorption is significantly slower, allowing the affected tooth to have a longer longevity.[15]

The inflammatory resorption is a reaction to a damaged PDL associated with a necrotic pulpal tissue. Microorganisms and toxins pass through the dental tubules and create an inflammatory reaction in the PDL. The result of this phenomenon is an osseous and radicular resorption.[1,12,16,17] Andreasen and Hjörting-Hansen[12] mentioned that the inflammatory resorption is significantly related to the root development, and is more evident in teeth with incomplete radicular development. This condition can be radiographically identified by the presence of a radiolucent peri-radicular area, surrounding areas of the root and of the adjacent alveolar bone. In its progression, it can destroy the radicular portion in few months, however it can be controlled through the elimination of the root canal irritants.[14]

The success of replantation depends on several clinical factors, which varies from 4% to 50%.[18,19]

The purpose of this article is to describe an esthetic and functional rehabilitating treatment of a young patient, who presented an unsuccessful upper central incisors replantation.

CLINICAL CASE REPORT

A 9 year-old boy was evaluated in March of 1993 at the Pediatric Clinic of Lutheran University of Brazil Dental School. He had a history of dental-alveolus trauma. The exam of the patient showed the absence of the upper left central incisor (tooth # 21), and a subluxation associated to a fracture of enamel and dentin without pulp exposure of the upper right central incisor (tooth #11). According to the caretaker, the trauma had happened due to a bicycle crash, approximately 60 minutes prior to the appointment.

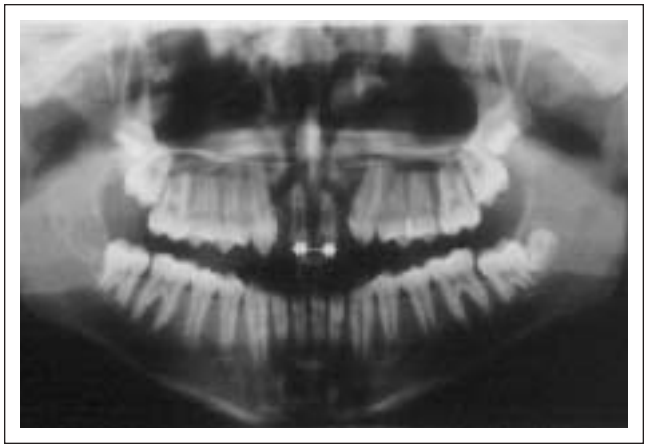

Figure 3. Periodic radiographic exam. (April - 1996).

Figure 4. Periodic clinical exam. (March - 1998).

Figure 5. Orthodontic treatment concluded. (March - 1999).

Figure 6. Clinical aspect after aesthetic-functional rehabilitation. (June - 1999).

The avulsed tooth was immediately stored in water. Replantation of tooth # 21 proceeded due to the favorable conditions found for a conservative treatment approach, evidenced by the age of the patient, extra-alveolar period and storage under wet conditions.

Initial treatment consisted of cleaning and anesthetizing the area, and repositioning of the tooth using digital pressure. A semi-rigid splint was prepared with orthodontic wire, fixed with composite resin on the buccal surfaces from canine to canine. The splint remained in place for a period of 7 days. The restoration of tooth # 11 was done in the same appointment. Antibiotic coverage (Amoxacilin™) and mouthrising with a clorhexidine solution (Periogard™) 2 times a day for 7 days was prescribed. (Figure 1).

In the second appointment, 7 days after the accident, due to favorable conditions, the splint was removed. Based on clinical and radiographic follow up it was possible to expect a revascularization and maintenance of tooth # 21 vitality.

At the first recall, 30 days after the trauma, it was possible to observe radiographic signs of inflammatory radicular resorption in teeth numbers 11 and 21. Endodontic treatment was immediately established, including the application of calcium hydroxide paste, used to fill the root canals entirely. Radiographic follow up showed an increase of radicular resorption in tooth # 21 and a stabilization of the process in tooth # 11. After the second change of the calcium hydroxide paste (6 in 6 months), conventional endodontic treatment of tooth # 11 was done (Figure 2).

In agreement with the patient and caretaker, a decision for the orthodontic treatment was made. This treatment was followed by a rehabilitating restorative treatment, due to tooth #21 progressive root resorption and the unfavorable prognosis for tooth #11. Orthodontic radiographic exams showed a skeletal and dental relationship of class II and increased overbite. Orthodontic treatment consisted of two phases.

In the first phase, central uppers incisors (#s 11 and 21) were extracted followed by the placement of a removable partial denture with artificial teeth. These acrylic teeth were trimmed out at the distal surface as the lateral incisors (teeth #s 12 and 22) were mesialized by using fixed orthodontic appliances. In order to stimulate a more mesialized eruption of the upper canine

(#s 13 and 23), the deciduous canine (teeth #s 53 and 63) were extracted and the patient received orthodontic braces segmented in the upper lateral incisors (#s 12 and 22) to avoid distalization (Figure 3).

The second phase of the orthodontic treatment consisted of bonding orthodontic braces, using the Edgewise technique, in both arches, and a class III mechanics with intermaxillary elastics associated with "sliding jig" for mesialization of either the upper canine (teeth #s 13 and 23) and the first upper pre-molar (teeth #s 14 and 24) (Figure 4). After the completion of this phase, a lingual bar was used as a retainer, bonded to the lower canines. For the upper arch a partial removable appliance was made. Pulp tests were done periodically in teeth #s 12 and 22, throughout the orthodontic treatment. Motivation of the patient regarding the control of the bacterial plaque was low, so the retainers were often removed to be readapted. (Figure 5).

The last step of the treatment was the reshaping of the upper lateral incisors and canines, veneering them with composite resin, making the appearance of central incisors and of canines, respectively.

Initially teeth were measured in mesial-distal diameter, as well as the height of gingival margin (length of the teeth), and occlusal registration was made. A major concern of the caretaker was to avoid any of tooth preparation. This concern was exactly in accordance to the treatment plan, however, it was advised that, particularly the canines, would be very difficult to match to an lateral incisors, due to size, contours, and shade.

Composite resin veneers were planned for this case, based on the adhesive properties that do not require cavity preparation, and because of the reversibility of the situation in case of an aesthetic unsuccessful result. Canines were previously bleached, to achieve a lighter shade as lateral incisors. A flexible tray with carbamine peroxide at 15% with fluoride (NuproGold - Dentsply™) was used for six hour per day, during 15 days. One week was awaited after the conclusion of the bleaching so that there was a stabilization of the shade.

Teeth were cleaned, and the appropriate resin and shades were selected, by placing small increments of composite resin on the buccal surface, followed by polymerization for the manufacturer suggested time. Lateral incisors were conditioned with phosphoric acid at 37% (Scotchbond Etchand™, 3M) for 30 seconds, in the buccal, proximal and palatal surface. Adhesive system was applied (Scotchbond Multi Purpose Adhesive™, 3M) with brush and each surface was polymerized for 20 seconds.

The veneers build-up consisted of the placement of a body layer (shade A3 - Z250™ 3M), that was taken to the proximal facets. This shade was applied from the gingival third to the incisal third of the crown. A microfilled resin (incisal shade - A110™ was applied from the medium third of the crown, overlapping the shade A-3 of the hybrid resin, creating the translucent aspect of the enamel. The new and longer incisal edge was built with Z-250™ Incisal (3M), due to the resistance of the hybrid resin, indicating the material for loading areas. The use of matrices was restricted to the acid-etching procedure to avoid adjacent surfaces conditioning, which could result in an undesirable splinting.

Restorations of the canines followed the same protocol, except that there was no resin placement in the gingival third in order not to increase the buccal convexity. The change occurred from the medium third of the teeth. Finishing procedures was accomplished with 12 fluted carbide finishing burs (KG Sorensen™), in low-speed, with intermittent refrigeration. These burs were used to delineate the shape of the teeth. Finishing disks (Sof-Lex XT Pop-On™, 3M) were also used in low speed. Scalpel blade #12 was applied at the gingival margins, for contouring and removal of excesses in those areas.

The occlusion checking was conducted at the end of the restorative procedure. The patient and caretaker were instructed regarding the resistance of the accomplished works, and that some cares had to be followed. It was also pointed out that there would be the sensation of "large teeth" immediately after leaving the restorative appointment, and a period of 7 to 14 days should be observed for a final and definitive sensation. At the end of 2 weeks the patient returned for a revaluation, when reported being quite satisfied with the result, and that he did not wish any shade change or reshaping. (Figure 6).

DISCUSSION

The dental trauma has been a frequent occurrence in the dental clinics and, most of the time, consists of an emergency situation, which requests immediate professional preparation to make the diagnosis and the treatment.

Avulsion is a complex injury that affects multiple areas and tissues, and it occurs in about 1 to 16% of the traumatic injuries.[2] According to the literature, the success of the dental replantation varies within 4 to 50%.[18,19] According to Krasner and Rankow[20], among the factors that influence the successful outcome of the replantation are the physiological state of PDL, the stage of radicular development and the extra-alveolar period.

Andreasen *et al.*[3] state that replantation accomplished immediately after avulsion can be successful in 85 to 95% of the cases in accordance to the stage of root development. Whenever immediate replantation is not possible, it is best to maintain the tooth in a wet media, preferably in milk, to avoid the dehydration and subsequent necrosis of the PDL. Water has been considered unfavorable media for storage by several authors, because hypotonicity conditions causes fast cellular lysis.[4,8,9,10] When an avulsed tooth is immediately placed in Viaspan or Hank's balanced salt solution, time does not become a critical factor for resorption, because these solutions increase the cellular vitality.[21]

The clinical protocol for replantation of avulsed teeth depends on specific clinical variables. When the replantation is accomplished in a period that the PDL is vital (total or partially), a new conjunctive epithelium is established in 7 days. Conjunctive tissue development and maturation of the fibers of PDL occur stimulated by occlusal function. Due to this, in the absence of alveolar fracture, splinting of the replanted teeth should be semi-rigid and should remain for a period varying from 7 to 10 days.[14]

The prognosis for a delayed replantation, however, is unsatisfactory. Inflammatory resorption is a problem after the replantation and it is closely related to the inner layers of the PDL and, possibly to the cementum. The osteoclastic action on the radicular surface exposes the dentinal tubules, establishing a communication with the necrotic pulp infected tissue. The resorptive process continues, leading to the loss of the dental element.[1,12,14,16,17] According to Andreasen and Andreasen[1] the treatment with antibiotic decreases the extension of the radicular resorption, however it has no effect on the pulp revascularization.

The protocol for the endodontic treatment of avulsed teeth recommends that the treatment should be implemented after the tooth has been replanted, minimizing the extra-oral time. This procedure should only be done before the replantation in those cases of teeth that have been stored dry for more than 120 minutes. Besides, the recommendation is to postpone the beginning of the endodontic treatment when the root is not totally formed and the extra-alveolar period is shorter than 120 minutes, due to the possibility of pulp revascularization after the replantation.[27] However, as soon as the pulp necrosis and/or the inflammatory resorption is detected, endodontic treatment should be proceeded.[1]

After the pulpectomy, the radicular canal should be filled with a calcium hydroxide paste as an attempt to inhibit the development of the inflammatory resorption.[22] Tronstad *et al*.[23] verified that the external resorption can be interrupted and repaired due to the high pH of calcium hydroxide. The increase of the pH determines decrease of the osteoclastic activity, preventing the dissolution of the mineral components of the root. Besides, an alkaline pH in the resorptive area will be unfavorable for the collagenase and for the acid hydrolysis activity of the resorptive cells, stimulating the alkaline phosphatase, which is an important factor in the formation and healing of hard tissue.

In spite of the beneficial action of calcium hydroxide, its use in the initial stages of the healing is not recommended due to the possible irritation to the traumatized PDL.[24] According to Nerwich *et al*.[25] the calcium hydroxide presents a harmful effect on the PDL cells of the replanted teeth. The diffusion of the hydroxide ions through the dentin can reach the periodontal space when the cementum layer is not intact, interfering in the healing of the PDL. The placement of the calcium hydroxide in the replanted teeth should be postponed between 7 and 14 days after the replantation, allowing the initial healing of the PDL[24]. Trope *et al*.[26] verified that the treatment with calcium hydroxide for a long time is important to control the inflammatory radicular resorption.

Mackie and Blinkhorn[27] prescribed the use of calcium hydroxide for periods of one year with changes every three months and, if after this period the tooth did not present signs of external radicular resorption, the endodontic filling could be done. Trope[1] indicates endodontic filling 6 to 24 months after the replantation, if the hard tissue is sound in the radiographic exam.

In the clinical case presented, authors intended to follow the protocol for the treatment of avulsed teeth, however, success was not obtained once the replanted tooth was compromised by external inflammatory resorption, resulting in the loss of tooth # 21. According to the scientific literature, there is a straight correlation between extra-alveolar period and storage media with periodontal healing and external radicular resorption.[4,10,28,29,30] In spite of the several variables present, the authors believe that the time factor and the storage in water were significant in the development of the progressive external resorption in the case described.

In those cases, the maintenance of the tooth is impossible due to resorption, it is necessary to establish a strategic treatment for rehabilitating the patient. According to the occlusion characteristics and the age of the patient, the treatment options involve the prosthesis, implants or orthodontics.

The clinical case described was conducted in a nine-year-old patient, still in his growing phase, which contra-indicated the option of implants and fixed prosthesis as the restoring procedure in that moment. Thus, the progressive resorption of the tooth # 21 and unfavorable prognosis of the tooth #11 guided the decision towards the extraction of these teeth, in agreement to the patient and caretaker. Extractions were followed by bonding orthodontic braces to mesialize lateral incisors and canines. As the orthodontic phase was completed, composite resin veneers were made to accomplish the esthetic rehabilitation. The orthodontic radiographic exams showed a skeletal and dental relationship of class II, mandibular deficiency in the anteroposterior direction and an increased overbite. These characteristics are also decisive for the establishment of the treatment plan.

Although the orthodontic treatment represents an option in which the cost and the time are to be considered, it is necessary to observe the young age of the patient and its dental and skeletal condition when planning the treatment. Besides, the fact that this treatment option discards the use of prosthesis seemed to have been important for the satisfaction of the patient.

REFERENCES

1. Trope M. Clinical management of the avulsed tooth. Dent Clin North Am 39: 93-112, 1995.

2. Andreasen JO, Borum MK, Jacobsen HL, Andreasen FM. Replantation of 400 avulsed permanent incisors. 4. Factors related to periodontal ligament healing. Endod Dent Traumatol 11: 76–89, 1995.
3. Andreasen JO. Effect of extra alveolar period and storage media upon periodontal and pulpal healing after replantation of mature permanent incisors in monkeys. Int J Oral Surg 10: 43-53, 1981.
4. Andreasen JO , Andreasen, FM. Textbook and color atlas of traumatic injuries to the teeth. 3 rd ed. Munksgaard, Copenhagen, Mosby, p. 771, 1994.
5. Kristerson L, Andreasen, JO. Influence of root development on periodontal and pulpal healing after replantation of incisors in monkeys. Int J Oral Surg 13: 313-323, 1984.
6. Cvek M, Cleanton-jones P, Austin J, Lownie J, Kling M, Fatti P. Effect of topical application of doxycycline on pulp revascularization and periodontal healing in reimplanted monkey incisors. Endod Dent Traumatol 6: 170-176, 1990.
7. Cvek M, Cleanton-jones P, Austin J, Lownie J, Kling M, Fatti P. Pulp revascularization in reimplanted immature monkey incisors – predictability and effect of antibiotic systemic prophylaxis. Endod Dent Traumatol 6: 157-169, 1990.
8. Blomlöf L, Otteskog P, Hammarstrom L. Effect of storage in media with different ion strengths and osmolarities on human periodontal ligament cells. Scand J Dent Res 89: 180-187, 1981.
9. Blomlöf L. Milk and saliva as possible storage media for traumatically exarticulated teeth prior to replantation. Swed Dent J Suppl 8: 1-25, 1981.
10. Blomlöf L, Lindskog S, Hedström K G, Hammarström K. Storage of experimentally avulsed teeth in milk prior to replantation. J Dent Res 62: 912-916, 1983.
11. Andreasen JO, Schwartz O. The effect of saline storage before replantation upon dry damage of the periodontal ligament. Endod Dent Traumatol 2: 70, 1986.
12. Andreasen JO, Hjörting-Hansen E. Replantation of teeth. I. Radiographic and clinical study of 110 human teeth replanted after accidental loss. Acta Odontol Scand 24: 263-86, 1966.
13. Andreasen JO, Hjörting-Hansen E. Replantation of teeth. II. Histological study of 22 replanted anterior teeth in humans. Acta Odontol Scand 24: 287-306, 1966.
14. Tronstad L, Debelian GJ. Reabsorções radiculares: etiologia, manifestações clínicas e terapia. In: Melo LL. Traumatismo Alvéolo-Dentário: Etiologia, Diagnóstico e Tratamento. São Paulo: Artes Médicas: EAP-APCD, p. 129–157, 1998.
15. Barret EJ, Kenny DJ. Avulsed permanent teeth: a review of the literature and treatment guidelines. Endod Dent Traumatol 13: 153–163, 1997.
16. Andreasen JO. Relationship between surface and inflammatory resorption and changes in pulp after replantation of permanent incisors in monkeys. J Endod 7: 294–301, 1981.
17. Pettini F, Pettini P. Root resorption of replanted teeth: SEM study. Endod Dent Traumatol 14: 144–149, 1998.
18. Gonda F, Nagase M, Chen RB, Yakata H, Nakajima T. Replantation: an analysis of 29 teeth. Oral Surg Oral Med Oral Pathol 70: 650-655, 1990.
19. Lenstrup K, Skieler V. A follow-up study of teeth replanted after accidental loss. Acta Odontol Scand 17: 503-509, 1959.
20. Krasner P, Rankow H. New philosophy for the treatment of avulsed teeth. Oral Surg Oral Med Oral Pathol 5: 616-623, 1995.
21. Trope M, Friedman S. Periodontal healing of replanted dog teeth stored in Viaspan, milk, Hank's balanced salt solution. Endod Dent Traumatol 8: 183-188, 1992.
22. Hammarström, L, Blomlöf, L, Feiglin, B, Lindskog S. Effect of calcium hydroxide treatment on periodontal repair and root resorption. Endod Dent Traumatol 2: 184-189, 1986.
23. Tronstad L, Andreasen JO, Hasselgren G, Kristerson L, Riis I. pH changes in dental tissues after root filling with calcium hydroxide. J Endod 7: 17-21, 1981.
24. American Association of Endodontics. Recommended guideline for the treatment of avulsed tooth. Chicago, 1994.
25. Nerwich A, Figdor D, Messer HH. pH changes in root dentin over a 4-week period following root canal dressing with calcium hydroxide. J Endod 19: 302-306, 1993.
26. Trope M, Moshnov J, Nissan R, Buxt P, Yesilsoy C. Short vs. Long-term calcium hydroxide treatment of established inflammatory root resorption in replanted dog teeth. Endod Dent Traumatol 11: 124-128, 1995.
27. Mackie IC, Blinkhorn AS. Dental trauma: 4. Avulsion and replantation of immature incisor teeth. Dental Update 23: 201-208, 1996.
28. Andersson L, Bodin I, Sörensen S. Progression of root resorption following replantation of human teeth after extended extraoral storage. Endod Dent Traumatol 5: 38-47, 1989.
29. Van Hassel HJ, Oswald RJ, Harrigton GW. Replantation 2. The role of the periodontal ligament. J Endod 6: 506–508, 1980.
30. Lekic P, Kenny D, Moe HK, Barret E, McCulloch CAG. Relationship of clonogenic capacity to planting efficiency and vital dye staining of human periodontal ligament cells: implications for tooth. J Periodontal Res 31: 294– 300, 1996.