



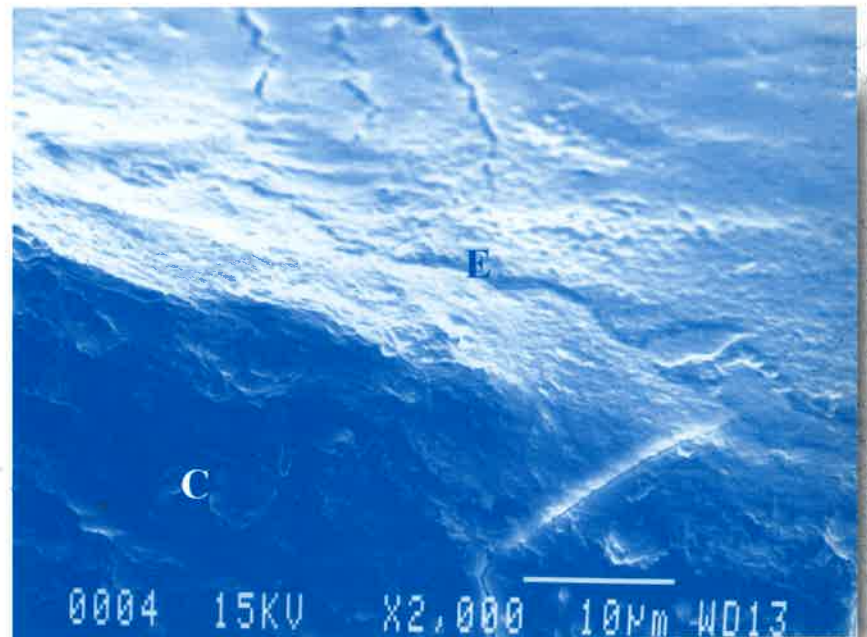
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SEM 2000 X. Cementoenamel junction: gap between cementum (C) and enamel reveals a strip of exposed dentin

Cementoenamel junction of deciduous teeth: SEM-morphology (E. Ceppi, S. Dall'Oca, L. Rimondini, A. Pilloni, A. Polimeni)

A
ARIESDUE

Clinical evidence and literature to compare two different therapeutic protocols in tooth avulsion

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ABSTRACT. *Aim* This is to assess the priority in tooth avulsion: replantation as quickly as possible and deferred endodontic treatment, or replantation and elimination of every irritating stimulus for the periodontal ligament. The objective is to establish a univocal protocol by analysing and comparing the various components of these therapeutic procedures. **Materials and methods** Study design: 20 patients were selected and divided into 2 groups: in group A we focused our attention on the rapidity of replantation, in group B we focused on the elimination of the necrotic pulp and every possible irritating stimulus that might lead to root resorption of inflammatory nature. **Results** Clinically, dental mobility seems to be greater in the first group. However after 15 days teeth have a comparable mobility and after one month they all show a mobility degree 1. Radiographically a greater incidence of resorption can be observed in group A compared to group B as in the first one a higher number of replanted teeth undergo resorption. Such lesions have the tendency to remain constant or even increase. **Conclusions** The results of this study seem to take only one direction: extraoral endodontic therapy.

KEYWORDS: Tooth avulsion, Therapy, Endodontics.

Introduction

According to the current classification of dentoalveolar traumas, based on the system adopted by the WHO in "Application of International Classification of Disease to Dentistry and Stomatology" [WHO, 1992], tooth avulsion (Exarticulation) is defined as the complete removal of the tooth out of its socket.

Several statistics have shown that the avulsion following dentoalveolar traumas is not a frequent event, ranging between 0.5-16% in the permanent dentition and 7-13% in the deciduous one, respectively [Andreasen, 1970; Down, 1957; Gelbier, 1967; Hedegard and Stalhane, 1973].

The main aetiologic factors in the permanent dentition are scuffles and sport [Andreasen, 1970; Kemp et al., 1977] while in the deciduous one they are, more frequently, falls against hard, inelastic objects.

Both in the permanent and deciduous dentition, the teeth that more frequently undergo avulsion are the central upper incisors, while the lower ones are usually

less involved [Andreasen, 1966; 1995]. Avulsion occurs especially in children from 7 to 9 years old, the period when the permanent central incisors are bursting out. At this age the periodontal ligament (LPD) can oppose little resistance to the extrusive forces.

More frequently the avulsion involves a single dental element, but cases of multiple avulsions are also reported.

The accurate pathological anamnesis becomes fundamental in the management of dentoalveolar traumas and particularly in the occurrence of dental avulsion.

Fundamental variables in determining the success or failure of the therapy are:

- traumatic mechanism;
- morphostructural integrity of the element and its socket;
- time frame between trauma and replantation (extraoral time);
- length of time that led to dehydration of the element (dry time);
- media chosen for preservation (medium);
- temperature of preservation.

International indications suggest the immediate

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replantation [Flores et al., 2001; AAE, 1995; RCSE, 1997].

The therapy aims to avoid or minimise the inflammatory reactions occurring as direct consequence of the avulsion.

The single factor playing a fundamental role in dental replantation's success is the speed of replantation. The critical value between success and failure is 15-20 minutes from the traumatic event, hence a proper and immediate reaction becomes a key variable. Being the extraoral time one of the main factors for the prognosis of such traumas, pre-treatment radiographs should be only taken when the socket integrity is doubtful since this phase could further delay the action time.

Before proceeding to the replantation, the following factors must be considered.

- 1 The tooth does not have to show an advanced damage of LPD.
- 2 The socket has to be relatively intact in order to provide a stable site for the avulsed tooth.
- 3 The extra-oral and the dry time are fundamental variables for the therapeutic choice.

In most cases the replantation of an avulsed tooth can be performed, even of elements with a doubtful prognosis. The literature reports cases in which replanted teeth have had longevity equal to healthy teeth, assessed both clinically and radiographically.

The management of dental avulsion is a disputed matter [Kenny et al., 2003]. As for every trauma, the therapeutic intervention has to be determined by the application of the best scientific evidences and considering the clinician's experience and patient's expectations. Therefore guidelines based on scientific, clinical and technical evidences should be drawn to allow the clinician a rapid and univocal application.

The many controversies emerging from the literature review open the field to further studies.

A number of guidelines have been published about the replantation of avulsed elements by organizations such as the American Association of Endodontics, the Royal College of Surgeons of England and the International Association of Dental Traumatology. Although there are many similarities, it is evident that these documents often include personal opinions and anecdotal information [Barrett and Kenny, 1997]. For instance, guidelines about elements with doubtful prognosis are not included, as well as the orthodontic implications related to patients with malocclusions and the direct and indirect cost of replantation. Most of these papers consider conference consensus based on researches published more than 5 years ago.

In order to achieve a short time success, it is

fundamental to consider the endodontic conditions: an inadequate treatment or the lack of treatment can lead to pulpal necrosis, infection and radicular resorption. A proper, adequate endodontic treatment given in a timely fashion is therefore crucial.

An immediate endodontic treatment with calcium hydroxide can lead to an increased frequency of apical ankylosis caused by the infiltration of cytotoxic substances used during the therapy, which can move from the apical foramen and contact the LPD during recovery [Hammarstrom et al., 1986; Andreasen and Kristerson, 1981]. For this reason it is advisable to start the intraoral treatment 7-10 days after replantation. This timing should be considered a compromise [Andreasen JO, 1992] since by that time hollow spaces of radicular resorption are already formed [Andreasen, 1975; Trope et al., 1992].

The resorption process is extremely rapid and deferring the endodontic treatment just for few days can be deleterious (Kinirons et al., 1999). Clinical studies report incidence rates of resorption processes after replantation of 25-39% [Kinirons et al, 1999] and 27-37% [Andreasen, 1995] in teeth filled in a conventional way, related to treatment timing and root formation, respectively.

The extraoral treatment can be orthograde or retrograde, using guttapercha and cement [Andreasen and Hjorting Hansen, 1966 a,b]. Some authors propose the retrograde insertion of a ceramic or titanium post, the validity of this technique being proved by years of clinical experiences [Pohl et al., 2003]. Experimental short-term studies on animals have shown a reduction of resorption in elements extraorally treated [Hammarstrom et al., 1986; Nasjleti et al., 1982; Andreasen, 1981 a, b]. The extraoral treatment is discouraged by the most authoritative texts of dentoalveolar traumatology and by international guidelines [Flores MT et al, 2001; AAE, 1995; RCSE, 1997]. The IADT and the AAE do not mention it, while the RCSE suggests the treatment in cases of long extraoral time. In the supplement to the IADT guidelines, Trope suggests the extraoral therapy as a secure method to achieve a complete apical seal for elements with formed apex and extraoral time longer than 60 minutes [Trope, 2002]. Such option is criticised essentially because it increases the LPD damage, due to the prolonged extraoral time.

Two short-term studies on animals show an increased percentage of ankylosis in elements extraorally treated (about 5.5% of the whole radicular surface) in a period of 8 weeks, comparing them with non treated elements (about 1.5%) [Andreasen and Kristerson, 1981].

In a clinical study the timing of the endodontic treatment had no influence on the degree of resorption [Andreasen and Hjorting Hansen, 1966].

A study on animals compares the effect of the calcium hydroxide treatment and extraoral treatment; it draws that 2/3 of the radicular surface of elements extraorally treated undergo resorption, while the hydroxide is able to reduce such problem [Lengheden et al., 1991].

From what has been described it is easy to infer that, within the dentoalveolar traumatology and especially the management of dental avulsion, there are many controversies and that a univocal internationally recognised protocol does not exist. The field open to discussion and scientific research is, hence, extremely broad. Within this context there is the willingness from our part to conduct a study aiming to solve what appears to be the main deficit detected through the meta-analysis of the international literature: the avulsed tooth's endodontic management.

Authoritative sources disagree and dissociate in establishing which should be the therapeutic approach in dental practice.

This study focuses particularly on the management of avulsed elements that have completed the radicular formation and therefore do not have an open apex.

In order to tighten the field of action, the focus moves onto the management of avulsed elements with an extraoral time greater than 60 minutes.

In fact this timing is the limit about which exists a consensus, and that allows us to differentiate the following therapeutic plans:

- before 60 minutes the priority is the replantation, as soon as possible, with the endodontic treatment deferred in time;
- after 60 minutes the confusion begins; which is the priority? replantation or elimination of every irritating stimulus for the LPD?

The objective of the study is to determine which has to be the priority. By analysing and comparing the results obtained by the different therapeutic methods we aim to establish a univocal protocol.

Materials and methods

The patients included in the study are among those visited, from January 2004 to January 2006, at the Dentoalveolar Traumatology Division of the Dentistry and Maxillofacial Surgery Unity of the Polyclinic of Modena.

The selection was based on the following criteria.

Criteria of inclusion

- Patients of both sexes.

- Patients with permanent avulsed teeth, with complete root formation.
- Patients with avulsed dental elements with an extraoral dry time longer than 60 minutes.
- Patients who gave, or who was given, written consent to participate in the study.

Criteria of exclusion

- Patients affected by decompensated diabetes.
- Patients affected by chronic and/or acute systemic diseases.
- Mentally incompetent patients.
- Patients in advanced pregnancy or nursing.
- Patients under pharmacological treatment that could interfere with the healing process of the gingival tissue.
- Patients with deciduous avulsed dental elements, or with incomplete root formation.
- Patients with avulsed dental elements with an extraoral dry time shorter than 60 minutes.

Eleven males and 9 females were selected.

The patients were then randomly divided into 2 groups (group A, group B) with a casual method not influenced by the physician or the patient's conditions.

Group A

The attention was focused on the rapidity of replantation. This method considers the regeneration of the periodontal ligament as a priority and the necrotic pulp is, at this time, not taken into account.

First appointment. The avulsed element is held by the crown and, under constant irrigation with salt solution, the residual fragments of LPD and any other possible irritating stimulus are removed from the radicular surface and then the cloth is removed from the socket (Fig. 1). An infiltration of local anaesthetic with vasoconstrictor is made. Replantation of the avulsed element requires a gentle manual pressure. A flexible splint should be placed, extending to at least 2 distal elements and 2 medial, with a steel bracket and passive arch or, if this configuration is not possible, composite and orthodontic arch (Fig. 2). The correct replantation of the tooth is radiographically checked; in order to standardise the analysis an individualised film holder was used (made for every single patient with a Rinn's film holder to which a layer of light-cured resin is applied) (Fig. 3). If there is a gingival laceration, this is sutured with Vicryl rapid. Amoxicillin and clavulanic acid antibiotic therapy is prescribed: 2 tablets/day for 6 days. Rinses with Chlorhexidine at 0.2%, 2/3 rinses a day for 2 weeks are prescribed. A semi-liquid diet is recommended for the following 10 days.

Second appointment (after one week). Removal of

the orthodontic arch and clinical assessment of the replanted element's stability. An x-ray with individual Rinn's film holder is taken, to look for possible signs of bone and/or radicular resorption. Access to the pulpal room with a three steps standardised technique includes the following.

- Penetration, with diamond round bur.
- Widening, with round bur.
- Finishing and cone shaping with a non working tip cone drill.

Pulpectomy is performed with manual steel tools, type K-files, and partially outlining of the radicular channels system, under constant irrigation with EDTA liquid at 17% and NaOCl at 5.25%. Application of calcium hydroxide, diluted with salt solution, inside the canal system, positioning of a cotton pellet and temporary filling with zinc oxide-eugenol. An intra-oral x ray is taken.

Third appointment (after two weeks). Splint removal and clinical evaluation of the replanted element's stability. An intra-oral x-ray with individual Rinn's film holder is taken, to look for possible signs of bone and/or radicular resorption (Fig. 4). The cotton pellet and zinc oxide-eugenol filling are removed, then the outline of the canal system is finalised with a mixed technique using standardised steel and Ni-TI tools:

- Apical widening and partial outlining.
- Determination of the working length and evaluation of the apical complexity.
- Manual and/or mechanical finishing of the third apical.
- Determination of the apical diameter and final outlining.

After the three-dimensional filling of the canal system by Thermafil technique, a control x-ray is taken.

Follow ups (after one, three, six and twelve months).

Clinical assessment of the replanted tooth's stability (Fig. 5).

Intraoral x-ray, with individual Rinn's film holder, to review for possible signs of bone and/or radicular resorption (Fig. 6).

Group B

The main objective was the complete removal of the necrotic pulp and all possible irritating stimuli that can lead to radicular resorption of inflammatory type. Unlike group A, in this case the priority is not the replantation as quickly as possible.

First appointment. The avulsed element is grasped by the crown and, under constant irrigation with salt solution, the residual fragments of LPD and any other

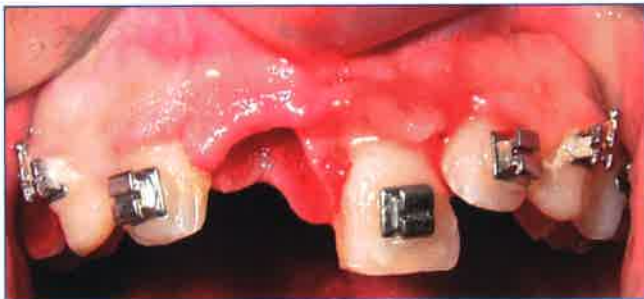


FIG. 1 - Patient (group A) 1 hour after trauma.



FIG. 3 - Patient (group A) after replantation and splint.



FIG. 2 - X-ray (group A) after replantation.



FIG. 4 - X-ray (group A) after 2 weeks.

possible irritating stimulus are removed from the radicular surface.

We perform an extra-oral endodontic therapy. Access to the pulpal room with a three steps standardized technique including the following.

- Penetration, with diamond round bur.
- Widening, with round bur.
- Finishing and cone shaping with a non working tip cone drill.

Outlining of the canal system is performed with a mixed technique using steel and standardized Ni-Ti and instruments:

- Apical widening and partial outlining, passive insertion of the steel K-files, N. 10 through 35, working only in exit.
- Determination of the working length and evaluation of the apical complexity.
- Manual and/or mechanical finishing of the third apical, using Ni-Ti files in a step-back mode, in order to achieve a uniform outlining of conicity .06 and diameter of point 20.
- Determination of the apical diameter and final outlining.

Alternate irrigation with EDTA liquid at 17% and sodium hypochlorite at 5.25% is required. Three-dimensional filling of the canal system by Thermafil

technique is performed. Temporary filling with zinc oxide-eugenol.

Through irrigation with saline solution the cloth is removed from the socket (Fig. 7). An infiltration of local anaesthetic with vasoconstrictor is made. Replantation of the avulsed element is performed with a gentle manual pressure. A flexible splint is placed, extending to at least 2 distal elements and 2 medial, with a steel bracket and passive arch or, if this configuration is not possible, composite and orthodontic arch (Fig. 8). The correct replantation of the avulsed element is radiographically checked; in order to standardise the analysis we use an individualised film holder (realized for every single patient with a Rinn's film holder to which a layer of light-cured resin is applied) (Fig. 9). If there is a gingival laceration, this is sutured with Vicryl rapid. Amoxicillin and clavulanic acid antibiotic therapy is prescribed: 2 tablets/day for 6 days. Rinses with Chlorhexidine at 0.2%, 2/3 rinses a day for 2 weeks are prescribed. A semi-liquid diet is recommended for the following 10 days.

Second appointment (after one week). After clinical assessment of the replanted element's stability, an x-ray with individual Rinn's film holder is taken, to look for possible signs of bone and/or radicular resorption.



FIG. 5 - Patient (group A) after 12 months.



FIG. 7 - Patient (group B) 1 hour after the trauma.



FIG. 6 - X-ray (group A) after 12 months.



FIG. 8 - X-ray (group B) after the replantation.

Third appointment (after two weeks). Splint removal and clinical evaluation of the replanted element's stability are performed. An intra-oral x-ray with individual Rinn's film holder is taken, to look for possible signs of bone and/or radicular resorption (Fig. 10).

Follow ups (after one, three, six and twelve months). After clinical assessment of the replanted element's stability (Fig. 11), an intra-oral x-ray is taken, with individual Rinn's film holder, to review for possible signs of bone and/or radicular resorption (Fig. 12).

Results

In order to compare the two different therapeutic methods and assess which one gave the best results, a careful analysis focusing on two parameters is performed: clinical and radiographical.

Clinical evaluation. The degree of mobility is clinically appraised for all of the replanted elements according to Miller's classification:

- degree 1, horizontal mobility of the crown of 0.2-1 mm;
- degree 2, horizontal mobility of the crown higher than 1 mm;



FIG. 9 - Patient (group B) after the replantation and splint.



FIG. 11 - Patient (group B) after 12 months.

- degree 3, added vertical mobility of the crown.

Radiographic evaluation. The degree of radicular resorption is appraised for all of the replanted elements radiographically. To this end, the analysis of the literature did not offer any useful reference or classification for establishing the degree, intensity and extension of the resorption. Therefore we decided to apply a new classification:

- light degree, radicular point resorption < 1 mm²;
- moderate degree, radicular point resorption > 1 mm²;
- severe degree, radicular resorption in different locations.

In order to optimise the evaluation, the root of every tooth is divided into three parts (coronal, middle and apical third) and subsequently a score is assigned to every third. This classification is made possible by the use of an individual Rinn's film holder; in fact this method, when applied to all of the patients, allows the retrieval of superimposed and therefore standardised x-rays.

It is recognized that a "parallel" x-ray taken in this way results in a 5% magnification of the image, which implies that a 20 mm tooth will appear 21 mm long. During the evaluation, this magnification has been considered negligible since 5% of 1 mm² cannot be visually detected.



FIG. 10 - x-ray (group B) after 2 weeks.



FIG. 12 - x-ray (group B) after 12 months.

Discussion

From the revision of the literature, it is clear that a standardised approach does not exist. Authors are in disagreement: some of them propose methods which are lacking of scientific support and based solely on personal clinical experiences, others propose methods that refer to a literature now dated.

The existing guidelines drawn by authoritative sources also lack of uniformity and often contradict each other. The above mentioned considerations are premise the for the present study. Therefore, the dichotomy that is established follows: elimination of any irritating stimuli for the PDL or replantation as quickly as possible?

The study analysed and compared the different methods underlined by the literature review in order to find out which of them can lead to the best results and to establish a univocal protocol.

Clinical evaluation. From this analysis it was observed that group A (Fig. 13) shows a greater short-term mobility compared to group B (Fig. 14). Both groups show positive results except one tooth belonging to group B, which had a negative course due to the prolonged extraoral time and a dry time longer than 40 minutes.

Mobility seems greater in the first group but, as already mentioned, after 15 days the mobility tends to show the same values and after one month all of the elements show a comparable mobility of degree 1. This pattern seems to be related to the different procedures chosen for the endodontic treatment. In fact, in group A the therapy was postponed one week after the replantation leaving the necrotic pulp in situ, which acted as a destabilising and infective agent. In group B the endodontic therapy was performed extra-

orally before replantation, thus eliminating every irritating stimulus. The results lead to assuming that there is a causal relationship between necrotic pulp and tooth stability.

Radiographic evaluation. Both groups did not show radicular resorption at 7, 15 days nor one month after the replantation. After 3 months in one patient of group A (Fig. 15) a small lesion of the apical third of light degree, < 1 mm², was detected. The same lesion, three more months later, increases in dimensions and becomes moderate in degree, remaining constant up to the next follow up.

Within the following six months a moderate degree of resorption the apical level is observed in two patients: in one the lesion will remain of the same dimension for one year, while the other patient will begin to recover. Finally, in a fourth patient a moderate degree of resorption is observed, at the apical level, after one year.

Group B (Fig. 16) does not show radicular resorption up to 6 months, when a patient shows a light degree lesion, apically, that however will be found recovered at the next follow up. One year later a second patient shows a moderate lesion at the apical level.

It can be concluded that group A underwent a higher incidence of resorption compared to group B; also in group A the lesions have the tendency to remain constant or become more severe.

The different behaviour seems to be related to the different therapeutic procedures. When the endodontic therapy has been performed immediately, removing the pulpal irritating stimulus, less cases of radicular resorption were observed and they were of a light degree.

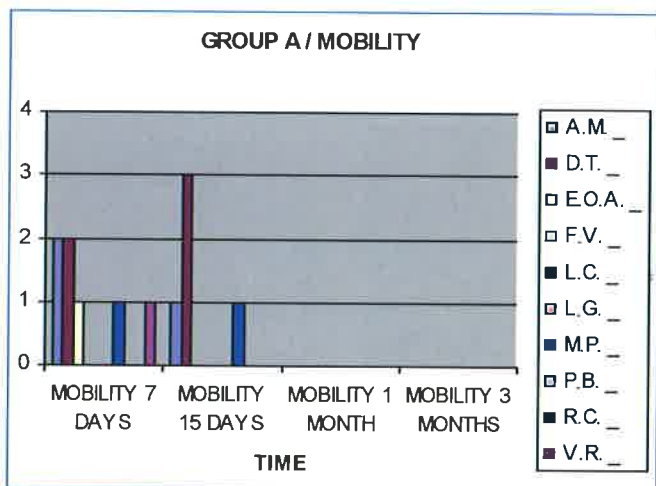


FIG. 13 - Mobility in group A.

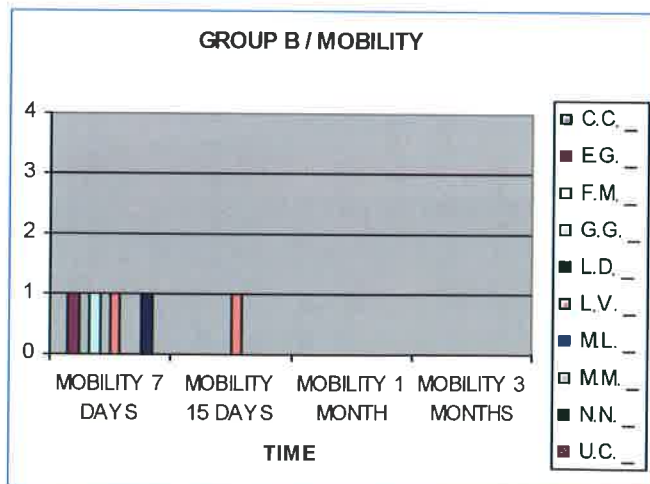


FIG. 14 - Mobility in group B.

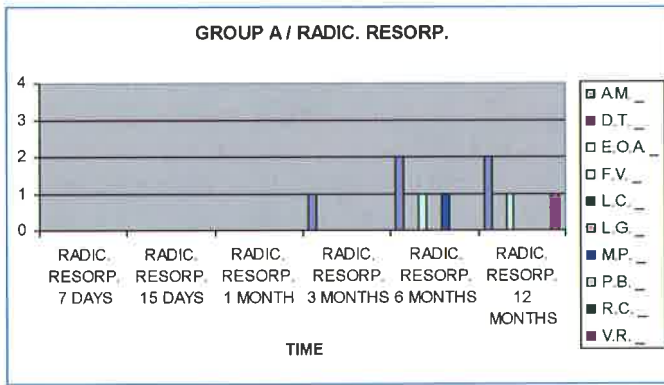


FIG. 15 - Radicular resorption in group A.

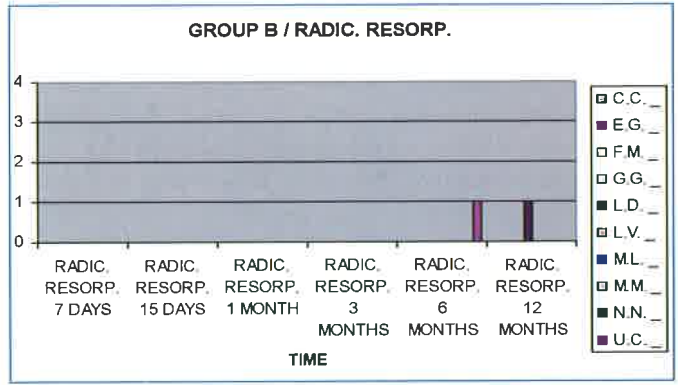


FIG. 16 - Radicular resorption in group B.

When it was decided to proceed with immediate replantation less incidence is observed.

Conclusions

The objective was to affirm, with certainty, what is the priority in the treatment of dental avulsion in a patient with an extraoral time greater than one hour and with mature apex.

In light of the results obtained by this study it is possible to state that the preferential treatment would be the protocol applied to group B. The immediate extraoral endodontic therapy seems to be the ideal method for the elimination of any agitating stimuli. At this stage, in fact, the prolonged extraoral time already lead to necrosis of the LPD and the pulpal necrosis is definitive. Proceeding to the immediate replantation and deferring the endodontic therapy will not be useful: the prolonged extraoral dry time will not allow the regeneration of the LPD cells, which is the principle on which this approach is based.

As observed from the literature review, there are different theories about the management of the avulsed teeth. The proposed guidelines are not sufficiently supported to be universally applicable and the field is open to discussion.

The results of this study seem to take only one direction: extraoral endodontic therapy.

The study will be continued, the purpose being to appraise the long-term behaviour of the replanted elements. At this time, however, the results seem to be unequivocal.

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