Autogenous Transplantation of Maxillary And Mandibular Molars

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Abstract: ***Objectives:*** To evaluate the validity and reliability of the autogenous transplantation of maxillary or mandibular molars. ***Methods:*** Ten patients received either a mandibular or maxillary third molar to replace a non restorable mandibular first or second molar. The clinical parameters were mobility and probing pocket depth. Radiographic assessment of progress of root development, periapical or periodontal radiolucencies, root resorption and ankylosis, was done by using digital panoramic radiographs with1:1 magnification correction. All clinical parameters and panoramic radiographs were taken at 2, 4, 6 and 9 months postoperatively. ***Results:*** The pocket depth readings and teeth mobility showed statistical significant decrease throughout the study. Regarding the radiographic results, no root resorption or ankylosis and 80% of patients had root development with no observed radiolucencies. ***Conclusion:*** The transplantation of developing molars in growing adults is a viable and reliable treatment option.
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1.INTRODUCTION

A significant number of patients have premature loss of their first and second molars because of dental caries and/or dental crowding. As a result; ridge resorption, malfunction, over eruption of opposing tooth, loss of space, temporomandibular disorder, etc..... may occur ***(Reich 2008)***. Removable partial denture and fixed partial denture are the options to solve these problems but they have their own disadvantages and limitations ***(Reich 2008)***. In planning the treatment for such cases, clinicians should make patients aware of other alternatives, including dental implants and transplantation of teeth ***(Cohen et al.,(1995)***. Auto-transplantation is a viable option for replacing a missing tooth when a donor tooth is available ***(Thomas et al., (1998);Lee et al.,(2001); Kim et al.,(2005); Teixeira et al.,(2006)***. Tooth auto-transplantation offers one of the fastest and most economically feasible means of replacing missing teeth ***(Cohen et al.,. 1995)***. While there are many reasons for auto-transplanting teeth, tooth loss as a result of dental caries is the most common indication, especially when mandibular first molars are involved. First molar erupt early and are often heavily restored. Auto-transplantation in this situation involves the removal of a third molar, which may then be transferred to the site of an unrestorable first molar ***(Clokie et al. ,(2001); Mejàre et al., (2004)***.

Teeth most commonly used for autotransplantation are premolars, canines, incisors (especially supplemental teeth) and third molars ***(Natiella et al., 1970)***. In theory, although any tooth may be transplanted, the donor tooth should be of limited value in the dentition, e.g. a premolar in a crowded arch, or a supplemental incisor ***(Thomas et al., 1998)***.

Zachrisson et al., (2004) found that after transplantation of partly formed rooted teeth, root growth continued, and the teeth maintained their capacity for functional adaptation. Endodontic treatment was usually not necessary. The optimal time for autotransplantation of premolars to maxillary anterior region was when the root development has reached two thirds to three fourths of the final root length. The prognosis for complete periodontal healing at this stage of root development was better than 90%. ***Reich et al., (2008)*** reported that after transplantation of 42 molar teeth with mean follow up 19 months transplants remained asymptomatic and functioning. No infection, ankylosis, loss of the transplant, or root resorption has been noted. In addition, endodontic therapy has not been necessary on any transplanted teeth. Auto-transplantation is a technique-sensitive procedure. A traumatic surgical technique preserves bone and periodontal support. Minimal handling of the transplant is required to protect the Hertwig's root sheath and pulpal tissue. A traumatic surgical removal of the third molar is essential, preserving the root sheath and apical

portion of the developing tooth bud. Adequate exposure and preparation of the recipient site are performed. Stabilization of the transplanted third molar is performed with suture material in a crossover fashion to prevent up-and-down movement of the transplant. Splinting with composite or wire banding isn't advised. Excessive time or rigid splinting of the transplanted tooth will adversely affect its healing ***(Tsurumachi & Kakehashi (2007); Reich(2008)***.The biological course of autotransplantated teeth is influenced by a number of preoperative, peroperative and postoperative conditions, which are recognized as prognostic factors. For example, age of the patient, developmental stage of the graft, the type of tooth transplanted, surgical trauma during graft removal and the extraoral storage of the transplanted tooth during surgery as concluded by ***Schwartz et al., (1985)***. The goal of this study is to highlight the evidence-based principles for successful autotransplantation; evaluating viability, reliability, lack of discomfort and complications, and stable occlusion of autogenous transplantation.

2.PATIENTS AND METHODS

2.1.Patients:

Ten female patients ranging from 16 to 20 years with a mean of 17.9 years were selected from the outpatient clinic of Oral and Maxillofacial Department, Faculty of Oral and Dental Medicine, Cairo University**.** Patients had non-restorable badly decayed lower first or second molar teeth requiring extraction and replacement with teeth (Figures 1 & 2).

2.2.Methods:

2.2.1.Operation:

**** Pre-operative assessment***

All patients fulfilled the following criteria:

- Non-restorable mandibular 1st or 2nd molar (Extracted tooth).
- Caries-free retrievable maxillary or mandibular 3rd molar (Auto-transplanted tooth).
- Recipient site having adequate bone support with sufficient alveolar bone support in all dimensions and adequate attached keratinized tissue (healthy periodontium).
- The sacrificed tooth was not lost due to terminal periodontal disease and/or acute inflammatory process.

**** Surgical procedure:***

Co-amoxiclav antibiotic prophylaxis was given preoperatively. After local anesthesia, non-surgical a traumatic extraction of the non restorable teeth were done using extraction forceps, or elevators in case of remaining roots. Adequate exposure and preparation of the recipient socket were performed with low-speed hand piece and surgical burs.

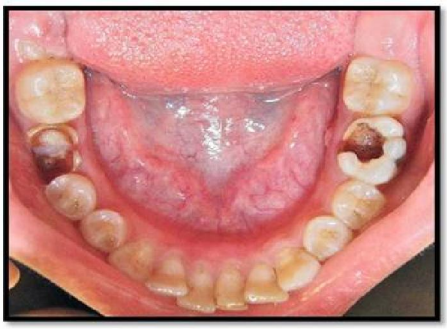

Figure 1: Preoperative photograph showing badly decayed non restorable lower left 1st molar.

Figure 2: Preoperative panoramic radiograph showing periapical & periodontal radiolucencies related to lower left 1st molar.

Copious irrigation with normal saline was used throughout the procedure. Trimming of the inter-radicular bone using bone rongeur was required to create a 4-wall surgically prepared bony socket. Additional removal of bone beyond the apex to ensure an apical cushion or tension-free zone where the root buds could be positioned without threat of compression. This apical preparation also allowed for the transplant to be positioned at/or slightly below the occlusal plane so as to avoid premature occlusal contacts. A traumatic extraction, avoiding disruption of the root sheath and root buds of the donor tooth. The auto-transplants were immediately transferred to the recipient site and seated in place with firm finger pressure. Care was taken to avoid any premature occlusal interference. The ideal position was considered to be 1 to 2 mm infra-occlusion allowing complete root development and eruption of the transplants. Stabilization of the transplants was achieved by 3/0 black silk **"Basket suture"**.

Postoperative antibiotic, analgesic and mouth wash were prescribed. Patients were strictly instructed not to masticate on the transplanted tooth. All patients were placed on a full liquid diet for 48 hours and then advanced to a pureed diet for 2 weeks. A soft diet was recommended for another 2 weeks.

Follow up visits:

Suture removal of donor and recipient sites were performed 2 weeks postoperatively. The patients were followed up for 2, 4, 6 and 9 months both clinically (Pocket depth and mobility) and radiographically (progress of root development, periapical or periodontal radiolucencies, root resorption and ankylosis).

2.2.2.10-mm Visual Analogue Scale questionnaire:

All patients examined at the last follow up visit (9 months) were asked to fill out a questionnaire that included six questions. Anamnestic perceptions of the transplantation procedure (two questions) and the present status of the transplanted tooth (four questions) were recorded on a 0 to 10-mm visual analogue scale (VAS). The patients indicated their opinion by marking a mark along the VAS; 0 was entirely positive and 10 was entirely negative.

2.2.3.Statistical Analysis:

Statistical analysis was performed using SPSS (Statistical package for social sciences) version 15, Echosoft corp., U.S.A. Unless otherwise specified, data were represented as mean ± standard deviation. Repeated measures analysis of variance (ANOVA) test was used to compare numeric variables within the studied group of patients. For categorical data, non-parametric ANOVA (Friedman's test) was performed to detect significant changes within the studied group of patients. Post Hoc test was done to identify the different group if ANOVA test was positive. In all tests, result was considered statistically significant if the *P*-value was less than 0.05.

3.RESULTS

3.1. Clinical assessment:

Clinical examination of teeth and soft tissues were performed on regular bases at 2, 4, 6 and 9 months' intervals. Tooth discoloration, premature contacts, occlusion, signs of infection and gingival color and contour were assessed during the examination. No positive findings were detected except for two patients (figures 5 to 8).

3.1.1.Pocket depth:

At 2 months, the minimum pocket depth was 3.50 mm and the maximum was 5 mm with mean of 4.25 mm. At 4 months, pocket depth started at 3.17 mm and ended at 4.67 mm with mean of 3.78 mm. On the other hand, a reduction was noticed at 6 months follow up visit ranging from 2.50 mm to 4.17 mm and mean of 3.25 mm. Further reduction at 9 months was detected with minimum of 2.17 mm, maximum of 4.17 mm and mean of 2.71 mm. ANOVA test showed statistical significant decrease ($P = 0.001$) in pocket depth throughout the follow up period (Figure 3).

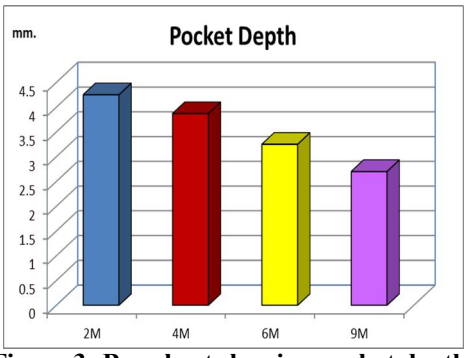

Figure 3: Bar chart showing pocket depths throughout the follow up period.

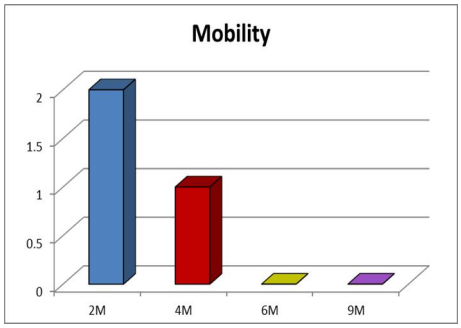

Figure 4: Bar chart showing mobility grades throughout the follow up period.

Figure 5: Two weeks follow up photographs of lower left 3rd molar transplant.

Figure 6: Nine months follow.

Figure 7: Two weeks follow up.

Figure 8: Nine months follow.

Since the ANOVA test was positive, Post Hoc test was done to determine the significant group of patients. In relation to 2nd month readings, the reduction at 4 months was not statistically significant $P = 0.274$ but at 6 and 9 months the reduction was significant $P = 0.002$ and 0.001 respectively. On the other hand, in comparison to 4th month readings, the decrease at 6 months was not statistically significant $P = 0.182$ but at 9 months the decrease was significant $P = 0.004$. Furthermore, 6 months readings compared to 9 months was not statistically significant $P = 0.286$.

3.1.2.Mobility:

Grade II mobility was noted at 2 months interval in all the studied cases. At 4 months, 90% of patients showed grade I, which was the minimum and the remaining 10% had grade II mobility that was the maximum with range and mode 1. On the other hand, a reduction was detected at 6 months follow up where 60% of the patients showed no mobility which was the minimum, 30 % had grade I and 10 % grade II that was the maximum with range 2 and mode 0. At 9 months, further improvement was noticed, 70% of the cases had grade 0 which was the minimum, 20% showed grade I and the remaining 10% were still grade II that was the maximum with range 2 and mode 0. Friedman test result showed statistical significant decrease ($P = .001$) in mobility throughout the follow up period (Figure 4).

Since the Friedman test was positive, Post Hoc test was done to determine the significant group of patients. There was a statistical significant change at 4 months, 6 months and 9 months compared to 2nd month grades($P = 0.001$) in all cases. On the other hand there was no statistical significant difference in mobility ($P > 0.05$) at 6 and 9 months when compared to 4 and 6 months intervals.

3.2.Radiographic assessment:

At the end of follow up period, radiographic assessment revealed that 8 patients (80%) had root development while the remaining 20% showed arrested root development. On the other hand, only 20% of cases had periapical or periodontal radiolucency while 80 % showed no radiolucencies. Neither of the patients had root resorption nor ankylosis (Figures 9 to 12).

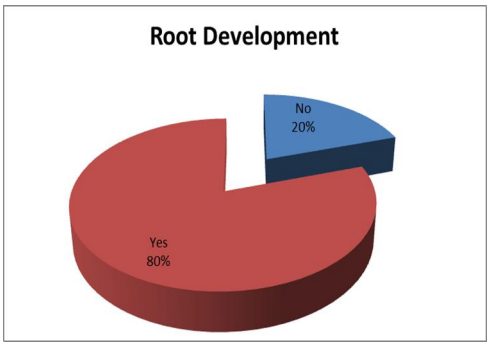

Figure 9: Pie chart showing root development of the transplants at the end of the follow up period.

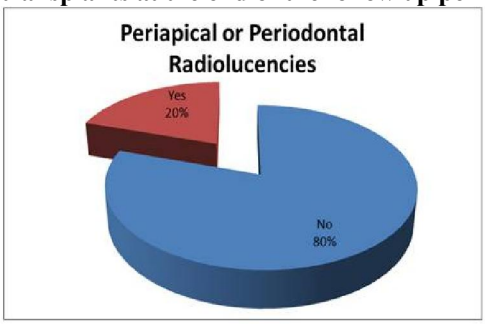

Figure 10: Pie chart showing periapical or periodontal radiolucencies of the trasnplants at the end of the follow up period.

Figure 12: Nine months postoperative radiograph of lower left 3rd molar transplant.

Figure 11: Two weeks postoperative radiograph of lower left 3rd molar transplant.

3.3. ***10-mm Visual analogue scale questionnaire:***

The patients received the autotransplantation as a somewhat painful procedure. Their decision to do transplantation was easy. Patients perceived the transplanted teeth quite different than others but they considered it to fit nicely in the dental arch. They didn't remember the original position of the transplants. Furthermore, patients had taken no particular measures to care for the auto-transplanted teeth.

4.DISCUSSION

Implant technology has taken great strides in recent years in terms of predictability, in both success rate &aesthetic result. Comparison between auto-transplantation & implantation as treatment options in replacing missing teeth seems inevitable. One major advantage of transplantation is its applicability in the management of patients before puberty growth has finished. Implants will not grow with growing patients and result in infra-occlusion as it becomes ankylosed to the alveolar bone. The beauty of transplanted teeth is that they are biological and able to erupt in harmony with adjacent teeth and growing jaws ***(Eddie 2009)***.

While there are many reasons for auto-transplantating teeth, tooth loss as a result of dental caries is the most common indication, especially when mandibular first molars are involved. First molars erupt early and are often heavily restored. Auto-transplantation in this situation involves the removal of a third molar, which may then be transferred to the site of an unrestorable first molar ***(Leffingwell 1980, Clokie et al., 2001, Reich 2008)***.In the present study, ten immature third molar teeth were autotransplanted as a replacement for unrestorable first or second molar teeth.

In the current study, all the patients were female with an age ranging from 16 to 20 years. Sex and age seem to have no effect on the final outcome. However, because immature teeth are usually covered by a thick follicle or periodontal ligament, which enables extraction of the transplanted tooth with minimal force, there are fewer chances of damaging the ligament during the procedure. That was in agreement with ***Cohen et al., (1995)*** who chose the patients having 15 years to 19 years and found that those patients are more appropriate candidates for third molar transplant.

The root length of the transplants in the present study was two-thirds root formation based on the study of ***Andreasen et al., (1990d*)** who reported that this was the ideal length. The main advantage of the open apex of the transplanted tooth with intact Hertwig epithelial root sheath allows healing and regeneration of the pulpal tissue and therefore saving subsequent root canal procedures. ***Andreasen et al,. (1990a & b)*** stated that the correlation between root length at the time of transplantation and vitality was: the more open the root apex the better the re-innervation. They found that teeth with incomplete and complete root formation showed 96 and 15 percent pulpal healing respectively. This discrepancy reflects the potential for revascularzation in teeth with open and closed apices. Furthermore, ***Skoglund et al., (1978)*** stated that the revascularization of the pulp appeared to occur mainly by in growth of newly vessels. In some instances, however, anastomoses seemed to form pre-existing vessels in the pulp.

Auto-transplantation is a technique-sensitive procedure as reported by ***Andreasen et al., (1988)***. So an atraumatic surgical technique was adopted in the current study following ***Kristerson & Andreasen (1984); Andreasen et al., (1990a);Cohen (1995) ;Teixeira et al., (2006)*** to preserve bone and periodontal support. Otherwise root growth may be compromised, leading to ankylosis or root resorption and attachment loss as stated by ***Slagsvold & Bjercke (1974) ;Nethander (1998)***. Furthermore, additional removal of bone beyond the apex at the recipient site was done to ensure an apical cushion or tension-free zone where the root buds could be positioned without threat of compression. This apical preparation also allowed for the transplant to be positioned at/or slightly below the occlusal plane so as to avoid premature occlusal contacts. Trimming of the interradicular bone using bone rongeur was required

to create a 4-wall surgically prepared bony socket to reduce lateral forces. This was in accordance with ***Bauss et al. (2002) and Reich (2008)***. Close contact of the autotransplanted tooth with the alveolar bone of the recipient site was assured as it is believed that this might provide better blood supply and adequate nutrition to the periodontal ligament cells, thereby increasing the number of viable cells as stated by ***Kallu et al., (2005)***. All the transplants were placed just slightly below the occlusal level to prevent postoperative traumatic occlusion as stated by ***Thomas et al., (1998)***; ***Clokie (2001) ;Bauss et al. (2009).*** Extra oral storage time if exceeding half an hour has an adverse influence on the results ***(Andreasen et al., 1970)***. Since the graft tooth was extracted immediately before grafting, injury to the periodontal membrane was minimal. This technique was applied in the present study, as it is likely to improve the clinical course after autotransplantation of teeth and avoid desiccation, which was confirmed by ***Kristerson & Andreasen (1984); Andreasen et al., (1990a&d) ; Honda et al., (2010)***.

A "basket suture" that runs across the occlusal surface of the transplant was selected as a type of splinting in the current study. That was in agreement with ***Bauss et al., (2002)*** who compared between rigid fixation and suture splinting "basket suture" for a total of 76 transplanted germs of third molars. Then they found that the significant increases in ankylosis and pulp necrosis were the factors for the less favorable results of the rigidly fixed teeth. Also ***Sagne & Thilander (1990)*** advised using flexible splinting where this allows for some physiological movement of the transplants functional stimuli assist healing. It's suggested that this movement stimulates periodontal ligament cellular activity and bone repair Two weeks of fixation period was adopted in the present study following ***Andreasen et al., (1990a & c); Lundberg & Isaksson (1996); Marcusson & Lilja-Karlander (1996); Frenken et al., (1998) ;Czochrowska et al., (2000)***. Furthermore, ***Pogrel (1987)*** concluded that rigid long-term fixation of the transplanted teeth had adverse effects on the periodontal and pulpal healing of the tooth.

The survival rate in the present study is 100%, as after transplantation of ten molar teeth with nine months follow-up, all transplants remained present. Also, the success rate is 80%, as eight out of the ten transplants fulfilled the success criteria; transplantation was defined successful if the tooth was still present without evidence of abnormal mobility, pathological pockets, root resorption or periapical radiolucencies. This was in agreement with ***Reich et al., (2008)*** who had a success rate of 95.5% where the transplants remained asymptomatic and functioning. As well as, no infection, ankylosis, loss of the transplant, or root resorption has been noted. In addition, endodontic therapy has not been necessary on any transplanted teeth.

In the follow-up period subsequent to tooth trasnplanatation, clinical measurements obtained through probing pocket depths and tooth mobility tests, were used to evaluate the healing process (***Altonen et al., (1978); Bauss et al.,(2004); Czochrowska et al., (2002) ; Mejàre et al., (2004)***. Since it is controversial, vitality test was not performed in the current study. Commonly, the vitality of the tooth is determined by means of cold or electrical tests, or both ***(Andreasen et al. (1970);Bolton (1974)***. As the so-called "vitality test" is a test of neurologic function of the pulp, it has been argued that it is possible for the transplant to have an intact blood supply without being re-enervated i.e. without having a nerve supply. Such a transplant would register non-vital to a vitality tester. The regeneration of a nerve supply to the pulps of that autograft may not have developed to the degree necessary for it to react to electrical stimulus at the time it was tested. Thus, the importance of a positive reaction to a cold or an electrical stimulus is a matter of controversy ***(Guralnick & Shulman 1962).***

The statistical significant decrease in pocket depth throughout the follow up period may be explained by the osteoinducing potential of the periodontal ligament cells resulting in bone regeneration between gap of the walls of socket and transplanted tooth. This is a welcome phenomenon that was observed clinically and confirmed with radiographs in the current study. This was in agreement with ***Eddie (2009)*** who found that genetically the periodontal ligament cells could differentiate into fibroblasts, cementoblasts and osteoblasts thus explaining this osteoinducing phenomenon. Furthermore, Pulp regeneration can be expected in immature replanted teeth. The optimal reattachment of periodontal ligament occurred within two weeks after autotransplantation between the periodontal ligament connective tissues of the root surface and the recipient socket wall ***(Tsukiboshi 2002)***.

The initial increase of mobility followed by reduction was observed in the present study. This was in accordance to ***Wally et al., (1979)*** who attributed the reduction in the mobility in their study to improved occlusal relationship and reduction in inflammation. Similarly, ***Cary et al., (1979)*** confirmed that mobility increased initially after surgery and decreased later on and attributed this to the healing of the periodontal ligament and bone surrounding the transplanted tooth.

In the current study continued root growth was noticed in 80% of the cases.

This was in line with results of a study conducted by ***Zachrisson et al.,(2004)*** where the authors found that after transplantation of partly formed rooted teeth when the root development has reached two thirds to three fourths of the final root length, root growth continued, and the teeth maintained their capacity for functional adaptation. Also, endodontic treatment was usually not necessary. Furthermore, the prognosis for complete periodontal healing at stage of root development was better than 90%. On the other hand, the time when the root completes its development after transplantation has not been examined, and an answer to this question will have an impact on prognostic assessment and clinical protocols for post-surgery follow-up (***Myrlund et al,. 2004)***.

All the recipient sites in the present study had sufficient bony support in all dimensions and sufficient keratinized mucosa to enhance post-operative stability in agreement to ***Teixeira et al., (2006)***, except for two cases. Distal bone resorption with furcation involvement and periapical radiolucency were seen in one case, which could be explained as a consequence of long standing chronic infection preoperatively. No improvement was noticed in the following radiographic follow up. This was correlated to the clinical findings, which determined increased pocket depths at the 6th month follow up interval. This patient missed some of the follow up visits and then recalled at the 6th month follow up visit and reported the presence of premature contact in the transplant. On the other hand, the other patient showed improvement in bone.

Bone resorption and increased pocket depth were detected in one case in the current study, where ***Bauss & Kiliaridis (2009)*** concluded that incorrect positioning with absence of occlusal and interproximal contacts are frequent findings in transplanted teeth. Incongruity between recipient site and root morphology of the transplanted might the cause of the transplant failure tooth. Moreover, the mesial and distal surfaces of the transplanted tooth and the adjacent teeth should be in contact with each other. If an interproximal space existed between the transplant and one of the adjacent teeth, then this will lead to food impaction and trauma to the interproximal gingival tissues leads to irritation, inflammation and even pocket formation ***(Bauss et al., (2002)***.

No root resorption was noted throughout the follow up period of the current study. The perquisite for periodontal regeneration is the survival of the majority of cells from the periodontal ligament, which are in competition with osteoblasts and osteoclasts from the alveolar bone. If the latter are predominant, root resorption starts and there is a poor prognosis as stated by ***Negri et al.,(2008) and Harzer et al., (2009)***. The final position of the donor tooth, within the recipient socket, influences periodontal healing. The donor tooth should be placed so that one to two mm of width of the periodontal ligament stays above the bone crest to achieve an ideal biologic width. Otherwise, apical migration of epithelium may occur and result in vertical bone resorption (too deep placement) or long connective tissue attachment (too shallow placement) as concluded by ***(Tsukiboshi 2001)***.

No ankylosis was determined until the end of the current study. ***Berude et al,. (1988)*** stated that replacement resorption (ankylosis) usually occurs and is secondary to cemental or periodontal ligament damage. It is unpredictable and usually irreversible. ***Mine et al., (2005)*** suggested that occlusal stimuli promoted the regeneration of the periodontal ligaments and prevented dentoalveolar ankylosis, whereas excessive initial force might cause severe root and bone resorption.

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