

Immediate vs late orthodontic extrusion of traumatically intruded teeth

REVIEW ARTICLE

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Abstract – Although the published papers about this matter is limited to clinical case reports, the aim of this review was to quantify the success rate of immediate vs late orthodontic extrusion of traumatically intruded teeth. From 55 reports in a PubMed and Medline computerized search, 13 reported patients involving 22 traumatically intruded anterior upper teeth with orthodontic extrusion were selected. In the sample of 13 patients, six were males and seven females and the average age was 16.4 years old. The selection criteria were patients presenting traumatized anterior upper teeth resulting in intrusive luxation, with at least 1 year follow-up period. Orthodontic extrusive forces were applied in the immediate group within 10 weeks post-trauma, while in the late group the forces were applied only after 3 months post-trauma. Immediate and late orthodontic extrusion was extremely favorable. The success rate (without or with complications) was 95.4% against only 4.5% (1 tooth) because of inflammatory root resorption with rapid progression. All mature teeth (100%) were endodontically treated. Among the 12 immature traumatically intruded teeth, eight were endodontically treated and four were not. A high rate of success was reported in the literature in traumatically intruded teeth orthodontically extruded, either immediate or late.

Dental intrusion is the type of injury where an apical tooth displacement takes place and the correct denomination is intrusive luxation (1). This type of injury commonly occurs in anterior upper primary teeth because of the alveolar bone increased resilience (1). Although the intrusion of mature teeth occurs less frequently, when it does occur, it can compromise the tooth's longevity (1–5).

Depending on the intrusion luxation's severity the implications frequently involve: pulp necrosis, root resorption, ankylosis, pulp obliteration and loss of marginal bone support (1, 2, 4–6). Although pulp obliteration is interpreted as a vital reaction of the pulp to the traumatic injury.

Different approaches have been suggested for intrusive luxation injuries, although, the ideal treatment method for tooth repositioning is still controversial. The suggested techniques include: observation for spontaneous re-eruption, surgical crown exposure, orthodontic extrusion (with or without previous luxation of the intruded tooth) and surgical repositioning (4, 7, 8).

Observation for spontaneous re-eruption has been suggested for immature teeth (9, 10) There is some disagreement in that matter because of the low expectations on spontaneous re-eruption of mature teeth (1, 11, 12). The disadvantages are the need of periodontal surgery to obtain access of the root canal while waiting for spontaneous re-eruption and, the likely appearance of root resorption or ankylosis during the observation period (13). The immediate surgical repositioning method

is recommended, in most cases, for full intruded teeth (14) and, it can facilitate the orthodontic bonding for subsequent tooth movement.

Immediate orthodontic force on traumatically intruded teeth would facilitate the dental extrusion, allow an early endodontic access (4, 11–13, 15–24) and it can be considered a way to prevent the appearance of ankylosis (11, 12). This method although can increase the risk of external root resorption and marginal bone loss (25).

The main doubt between dental trauma and orthodontic treatment concerns the most appropriate time of initiating routine orthodontic extrusion after an injury (12). It is customary that this be delayed until the teeth are symptomless for at least a few months after the emergency treatment, while waiting for a periodontal re-establishment and spontaneous re-eruption of immature teeth (9, 10). This procedure would reduce the likeliness of root resorption (12). The observation period would facilitate the development of tooth ankylosis in the intruded position (7) and, delay the endodontic access of the intruded tooth (1).

There is a small quantity of reports regarding the effectiveness of immediate or late orthodontic extrusion in cases of luxation injuries. The published material about this matter is limited to clinical case reports. The most appropriate time of initiating routine orthodontic extrusion in traumatically intruded teeth is not well defined. The ideal treatment option would be the one with fewer possibilities of developing complications. The purpose of this study was to accomplish a review of

clinical cases to identify the most appropriate moment to initiate the orthodontic extrusion of the traumatically intruded teeth. As well as to distinguish a difference among immediate and late orthodontic extrusion regarding injuries such as, root resorption and ankylosis.

Material and methods

Search strategy

A PubMed and Medline computerized search in the literature (<http://www.ncbi.nlm.nih.gov>) from 1974 to April 2008 was performed to identify the maximum number of studies in which traumatically intruded teeth were orthodontically extruded. The information sources were periodicals in the following specialties; orthodontics, endodontics, pediatrics and oral surgery, published in English. 'Dental', 'Trauma' and 'Intrusion' were searched in the subject heading and then crossed with various combinations of the terms; 'traumatically', 'luxated', 'anterior teeth', 'extrusion' and 'ankylosis'.

Selection criteria

The review selection criteria for articles were traumatically intruded permanent anterior upper teeth, treated by orthodontic extrusion, reported post-trauma follow-up of at least 12 months. There were no root fractures in the group sample. The root resorption because of a traumatic injury can be observed, in most cases, from 2 to 5 months post-trauma (5). So that the 12 month post-trauma follow-up suggested in this study would be long enough for the root resorption to appear in the injured teeth.

The data were collected with a structured format that includes several items; age; gender; stage of root development (incomplete, complete); severity of intrusion (moderate, severe); time between the traumatic injury and the beginning of extrusion; duration of the orthodontic extrusion, appliance type (removable, fix), follow-up period and, the need of endodontic intervention.

The sample was divided in two groups according to the exact moment of extrusion since the initial trauma. In the immediate orthodontic extrusion group, the forces were applied within 7 weeks (mean of 17 days) post-trauma. While in the late orthodontic extrusion group, the forces were applied only after 3 months (mean of 204 days) post-trauma.

The clinical outcomes were evaluated according to the following situations: (i) case of success without complications: it was defined as a retained and asymptomatic tooth, with no radiographic signs of root resorption at the end of treatment; (ii) case of success with complications: it was defined as a retained and symptomatic tooth, presenting < 50% of root resorption at the end of treatment; (iii) case of insuccess: it was defined as an extracted tooth because of inflammatory root resorption with rapid progression.

Intervention and analysis

All intruded teeth were orthodontically extruded, with or without previous luxation. The data analyses were

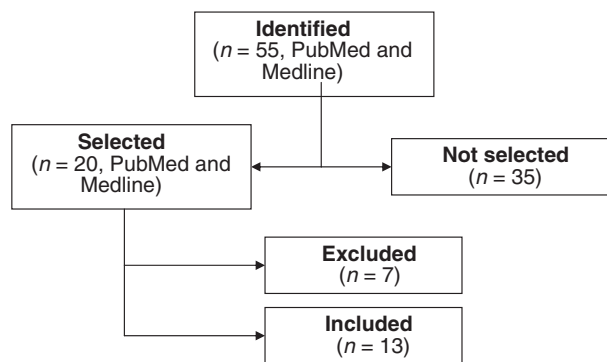


Fig. 1. Identified, selected, not selected, excluded and included articles.

performed, when possible, comparing the following groups: (i) result evaluation of the immediate orthodontic extrusion group (forces applied within 7 weeks post-trauma) vs the late orthodontic extrusion group (forces applied only after 3 months post-trauma); (ii) duration of the orthodontic extrusion between the two groups; (iii) stage of root development vs pulpar modifications between the two groups, (iv) severity of intrusion vs treatment success between the two groups.

Two reviewers will estimate independently the quality of the titles and abstracts from all identified articles during trial through the electronic search. When needed, a full copy of the article was obtained for the ones who apparently filled the requirements of the selection criteria. Fig. 1 shows the search strategy with the identified, selected, not selected, excluded and included articles.

The search strategy resulted in 55 articles. After the selection according to the inclusion/exclusion criteria reported earlier, 35 articles were not selected, 20 were selected, and out of these, 13 articles (11–13, 15–24) were qualified and included in the final review. The main reasons for the exclusion of seven articles were: spontaneous re-eruption (9, 10), immediate surgical repositioning (26, 27), literature review (28), insufficient follow-up period (10 months) (29) and, lack of case report (30).

The degree of intrusion such as moderate or severe was based in the authors' paper reports. Among the included articles, not all of the case reports and teeth were included in the study because of insufficient follow-up period (5 months and 7 months) 12 and mild intrusion (17).

Results

The Table 1 shows the data of the review sample. The time between trauma and the beginning of the extrusive orthodontic mechanics ranged from 6 to 365 days, with the sample divided in two groups: group 1 of immediate orthodontic extrusion, with the forces applied in a maximum period of 7 weeks post-trauma and, group 2 of late orthodontic extrusion, with the forces applied only 3 months or more post-trauma.

The success without complications was reached in 11 of 22 orthodontic extruded teeth (50%), which nine upper central incisors and two upper lateral incisors

Table 1. Characteristics of case related, included in this study

Authors	Year	Age gender	Tooth	Root development ^a	Degree of intrusion ^b	Beginning of extrusion (days)	Duration of extrusion (weeks)	Type of appliance	Endodontic treatment	Result ^c
Perez et al. (22)	1982	11/M	21	C	S	20	20	Removable	Yes	SC
Mamber (21)	1994	11/M	11	C	S	6	14	Removable	Yes	S
			21	C	S	6	20	Removable	Yes	S
Jacobs (17)	1995	9/M	11	C	M	46	10	Removable	Yes	SC
Alves et al. (15)	1997	7/F	21	I	S	270	48	Fix	No	S
Kupietzky et al. (20)	2000	8/M	11	I	S	7	6	Fix	Yes	SC
Chan et al. (13)	2001	60/F	11	C	M	14	6	Fix	Yes	SC
			21	C	M	14	16	Fix	Yes	S
Jang et al. (19)	2002	7.9/F	21	I	S	35	28	Removable	No	SC
Calasans et al. (11)	2003	50/M	11	C	S	7	8	Fix	Yes	S
			12	C	M	7	8 weeks	Fix	Yes	S
			21	C	S	7	8	Fix	Yes	S
			22	C	S	7	8	Fix	Yes	S
Sapir et al. (23)	2004	7.6/F	21	I	S	14	5	Removable	Yes	SC
Chausu et al. (12)	2004	8/F	11	I	M	26	12	Fix	Yes	S
			12	I	S	26	12	Fix	Yes	SC
			21	I	S	26	12	Fix	Yes	S
			22	I	S	26	12	Fix	Yes	I
Kalwitzki et al. (19)	2005	8/F	21	I	S	90	96	Removable	Yes	SC
			22	I	S	90	96	Removable	Yes	SC
Takahashi et al. (24)	2005	11.2/M	12	I	S	365	107	Fix	No	SC
De Alencar et al. (16)	2007	15/F	11	C	S	16	–	Fix	Yes	S

^aI, incomplete; C, complete.
^bM, moderate; S, severe.
^cS, success; SC, success with complications; I, insuccess.

(Table 1). The success with complications (it was defined as a retained and symptomatic tooth, presenting < 50% of root resorption at the end of treatment) was reached in 10 of 22 orthodontic extruded teeth (45.45%), which seven centrals and three laterals (Table 1).

Only one tooth (upper left lateral incisor) had to be extracted 9.5 months after the initial trauma because of a rapid inflammatory root resorption (unsuccess rate of 4.54%). All intruded mature teeth (100%) presented pulpar alterations or initiation of root resorption and endodontic treatment were performed with pulpar extirpation.

Among the 12 traumatically intruded immature teeth, endodontic intervention was performed in eight teeth (66.66%), while the four remaining teeth (33.33%) were left alone with no need of endodontic treatment. The immediate orthodontic extrusion group was formed by 18 teeth. The orthodontic forces were applied from 6 to 46 days post-trauma, (with a mean of 17 days). The duration of the orthodontic extrusion ranged from 5 to 28 weeks and the mean average was 12 weeks. Among the 18 intruded teeth, 10 teeth (55.55%) presented a successful result without complications, seven teeth (38.88%) presented success with complications and, one tooth (5.55%) was a case of insuccess. The late orthodontic extrusion group was formed by four teeth. The orthodontic forces were applied from 3 to 12 months post-trauma (with a mean of 204 days). The duration of the orthodontic extrusion ranged from 48 to 107 weeks and the mean average was 87 weeks (20.3 months).

The late orthodontic extrusion was performed for the following reasons:

1. The parents of the female patient, 7 years old, severe dental intrusion of the immature tooth 21, sought treatment 6 months post-trauma (15).
2. The parents of the female patient, 8 years old, severe dental intrusion of the immature teeth 21 and 22, sought specialized treatment in the following 24 h post-trauma. Although, the treatment choice included observation for re-eruption and radiographic follow-up. After 12 weeks, since the initial trauma, no signs of spontaneous re-eruption could be detected. However, the radiographic revealed slight signs of external root resorption on both intruded tooth, a finding that led to the indication of root canal treatment and orthodontic extrusion (19).
3. A male patient, 11.2 years old, severe intrusion of the mature tooth 12 only sought treatment 1 year post-trauma. His chief complaint was an anterior crossbite and malpositioned anterior incisors (24).

In the late orthodontic extrusion group, the success rate without complications was 25% (1 tooth), of success with complications was 75% (three teeth) and was no unsuccessfully one reported.

Among the 22 traumatically intruded teeth, five teeth were moderately intruded and 17 were severely intruded. In the moderate intrusion group, all were immediately extruded. As it shows in Table 2, 60% of the moderately intruded teeth were classified as success without complications, 40% as success with complications and there was no unsuccessfully case.

In the severe intrusion group with immediate extrusion 13 teeth (53.8%) were classified as success without complications, 38.4% as success with complications and the without success was 7.7%. In the severe intrusion

Table 2. The degree of intrusion, moment of extrusion (immediate or late) in relationship to success, success with complications and insuccess

Result	Moderate intrusion				Severe intrusion			
	Immediate ^a		Late ^b		Immediate ^a		Late ^b	
	No.	%	No.	%	No.	%	No.	%
Success	3	60	–	–	7	53.8	1	25
Success with complication	2	40	–	–	5	38.4	3	75
Without success	–	–	–	–	1	7.7	–	–
Total	5	100			13	100	4	
	5				17			

^aImmediate orthodontic repositioning.
^bLate orthodontic repositioning.

group with late extrusion (four teeth), 25% of these teeth were classified as success without complications, 75% as success with complications and, there was no unsuccessfully case (Table 2). Among the 11 traumatically intruded immature teeth, four teeth were submitted to late orthodontic extrusion and seven teeth to immediate orthodontic extrusion (Table 3).

In the immature teeth group with late orthodontic extrusion, it was observed that 50% were treated endodontically (access to the root canal, pulp extirpation and placement of a calcium hydroxide paste) and the other 50% were not. In the immature teeth group with immediate orthodontic extrusion, an endodontic intervention was performed in 85.7% of the teeth and only 14.3% of these teeth did not present the need of an endodontic intervention. Among the 11 traumatically intruded mature teeth, all of them were submitted to immediate orthodontic extrusion (Table 3).

The following orthodontic appliances were used:

1. Hawley modified removable appliance, with a 0.7 mm wire cut between the upper central incisors to form an active spring, which was positioned above the bonded orthodontic buttons on the intruded teeth, resulting in extrusion. The patients were usually re-scheduled every 2–3 weeks for orthodontic activation (17, 21–23).
2. Orthodontic accessories (Ormco, Diamond, pre-angulated), a 0.014NiTi segmental appliance was fabricated on primary canines, permanent centrals and the right upper lateral incisor (20).
3. Orthodontic attachments bonded to the intruded incisors that were carefully moved with a light pressure, not exceeding 20 g per incisor. A power

chain elastic connecting the orthodontic attachments to the removable orthodontic appliance with a palatal hook promoted extrusion (18, 19).

4. Fixed multibracketed appliance (Edgewise slot 0.022') bonded to the upper arch and, orthodontic bands on the first maxillary molars. A sequence of stainless steel multiloop arches was used: 0.012', 0.014', 0.016' and 0.018', replaced every 15 days (11).
5. Bands on the first maxillary molars with a palatal arch soldered unit, bonded buttons to the four upper incisors and, slotting of the self supporting labial arch to the buccal tubes of the molar bands. The extrusive movement was promoted by tying the incisor eyelets to the labial arch (12).
6. Palatal arch and an edgewise multibracketed fix appliance (0.018 × 0.025 pre-adjusted), orthodontic forces were applied to tooth 12 through a traction spring attached to the palatal arch. After 3 months without extrusive movement, ankylosis was diagnosed and, a surgical luxation was performed. Orthodontic traction was then applied with a power chain from the lingual arch. After 1 year and 6 months, since the initial trauma, Edgewise appliance was bonded to the maxillary arch. The application of orthodontic forces failed to extrude the intruded tooth and caused intrusion of the adjacent anchor teeth. Because tooth 12 showed no distinct root resorption, surgical extrusion was performed again and, a nickel-titanium alloy wire was used for maxillary leveling (24).

The type of fix appliance used in 3 of the 13 cases (13, 15, 16) were not described. The minimum clinical and

Table 3. Root development, endodontic treatment and immediate or late orthodontic extrusion

Endodontic treatment	Immature teeth				Mature teeth			
	Immediate ^a		Late ^b		Immediate ^a		Late ^b	
	No.	%	No.	%	No.	%	No.	%
Yes	6	85.7	2	50	11	100	–	–
No	1	14.3	2	50	–	–	–	–
Total	7	100	4	100	11	100	–	–

^aImmediate orthodontic extrusion.
^bLate orthodontic extrusion.

radiographic follow-up period was 12 months (12, 20, 21) and the maximum was 9 years and 10 months (17).

Discussion

The current state of knowledge regarding treatment of traumatically intruded teeth is based mainly on clinical cases. In this review the articles describing the treatment of upper incisors by orthodontic extrusion. The favorable outcomes reached in clinical cases reported in the literature must be handled with caution because of the potential biases in publishing successfully reports and usually failed single-patient reports are unlikely to be submitted for publication.

Among the 22 traumatically intruded teeth evaluated in this study, 16 were maxillary central incisors, seven were maxillary lateral incisors and the only case of without success reported was a lateral incisor that had to be extracted because of rapid inflammatory root resorption. The incidence of intrusive injuries in laterals was less frequent probably because of its minor prominence and smaller size.

Among the 22 traumatically intruded teeth, 14 (11–13, 15, 16, 20, 24) were repositioned with an orthodontic fix appliance and eight (17–19, 21–23) with a removable appliance. The multibracketed orthodontic fix appliance can be considered an excellent treatment choice by generating controlled dental movement with no patient's compliance. Although this procedure may not be recommended all times because of two main reasons: when the adjacent teeth have also been injured to some extent by the same blow and they probably need to be splinted, and the undesirable intrusion of the anchorage teeth when the injury teeth is ankylosed. The treatment choice in the eight remaining teeth (17–19, 21–23) was the removable appliance, the reason would be the distribution of force against the patient's palatal mucosa instead of overloading the adjacent teeth.

Surgical repositioning has been suggested to immediately relocate the severe and moderate intruded teeth, to allow early access of the root canal preventing an infection because of pulp necrosis (14). In critical cases with perforation of the nasal cavity the treatment choice may include partial surgical repositioning associated with orthodontic extrusion.

In this review, the results obtained with orthodontic extrusion immediate or late were considered favorable. During the evaluating period the success rate without and with complications was 95.45% and without success rate was only 4.54%. The result of success with complications was defined as a retained and symptomatic tooth, presenting < 50% of root resorption at the end of the follow-up, it means the tooth should be functional and could be maintained in the oral cavity for a long period of time.

The important decisions in the orthodontic treatment plan of young patients with injured teeth concerns the teeth's longevity. To maintain a tooth during a few more years means preservation of the alveolar ridge integrity in height and width, healthy gingiva and the space maintenance for future prosthetic restoration, if neces-

sary. Depending on the patient's age and facial growth, it is possible to maintain an ankylosed tooth as a space maintainer and an esthetic temporary until the restoration is performed (30).

In the immediate orthodontic group the extrusion ranged from 5 to 28 weeks (mean of 12 weeks), while in the late orthodontic group the extrusion ranged from 48 to 107 weeks (mean of 86.75 weeks), so the teeth in the immediate orthodontic extrusion group were relocated seven times faster in comparison to the ones lately extruded.

The results shown on Table 2 could suggest that when severely intruded teeth are submitted to late orthodontic extrusion there is a high probability of success. However, 75% of the late orthodontic extruded teeth present some degree of root resorption at the end of treatment, and only 25% is root resorption free according to the author's reports. Another issue compromising the full success of the late extrusion group compared with the immediate group is the small sample. The number of cases in the immediate extrusion group is three times higher.

It should be emphasized that 53.8% of the severely intruded teeth immediately extruded reached success without complications (no root resorption or ankylosis at the report) was performed in less time and presents a higher rate of success without complications. There is no evidence that the immediate use of force post-trauma can be the etiological factor of root resorption. The most likely cause of the root resorption should be the impact itself and these complications can happen regardless the use of orthodontic force.

To compare the immediate vs late orthodontic extrusion in traumatically intruded teeth, it would be desirable a homogeneous sample with the equivalent number of cases from each group. This balance was not reached because only a few cases were submitted to late extrusion. Evidence-based information to achieve healthy traumatically intruded teeth is required.

Conclusions

Based in literature's clinical case reports, it was observed that after 12 months after extrusion:

A high rate of success in traumatically intruded teeth orthodontically extruded, either immediate or late.

The duration of extrusion in traumatically intruded teeth submitted to immediate orthodontic extrusion occurred faster.

All mature teeth (100%) and most of the immature teeth (73%) underwent endodontic treatment post-trauma.

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