Treatment planning for the lost permanent incisor(s) in adolescents

Asbjørn Jokstad, DDS, PhD
Professor and Head, Prosthodontics
Faculty of Dentistry, University of Toronto
Dental injuries due to trauma in sports - Finland 1987-91 n=54186

Tooth Injuries in Sports – Intra-oral location

Football, 1979 (n=223)

Basket, 1989-92 (n=273)

Football, 1982 (n=258)

Source: Nysether, S. U. Oslo, 1985
Reasons for loss of incisors

**Trauma**
1. Fracture
   - Jaw
   - Crown-root
   - Root – cervical / middle / apical
2. Exarticulation ("avulsed tooth")
3. Post trauma complications
   - Inflammatory root resorption
   - Ankylosis
4. Ectopic teeth
1. Fractures
Jaw fracture

Accident, age 10
Multiple corpus & condyle fractures
11 & 12 lost immediately
14 & 21 later
Jaw fracture

Age 10
Corpus & condyle
11 & 12
14 & 21

Autotransplant
Orthodontics
Composites

Alveolar Bone

Faculty of Dentistry,
University of Oslo, Depts. of
Pedodontics, Orthodontics &
Prosthodontics. Stenvik &
Crown–root fracture

2mm below bone level palatinally

Crown–root fracture

Surrounding tissues follow the fragment

2mm below bone level palatinally

Crown–root fracture

Surgical repositioning
(intraalveolar transplant)
180 degrees rotated

Fixate min. 2 weeks before crown therapy

Faculty of Dentistry, University of Oslo, Depts. of Pedodontics, Orthodontics & Prosthodontics.
Root fracture  Cervical 1/3 third.
Root fracture  

Cervical 1/3 third.

Root fracture

Middle 1/3 third.

Faculty of Dentistry,
University of Oslo,
Root fracture

Middle 1/3 third.

Schwartz-Arad et al., 2004
1. Fractures

2. Exarticulation
Exarticulation

- 0.8-1.7% of all tooth damages are avulsions
- Slightly higher % loss due to later root resorption and ankylosis  
  (Scandinavia, 1995)
- Replanted teeth: 22% lost after 2.5 years  
  (7% cervical resorption, 3% epithelial downgrowth, erupting canine, pre-orthodontic consideration, root resorption, 2% endodontic failure, new trauma  
  (Ebeleseder et al., 1998)
1. Fractures
2. Exarticulation
3. Post-trauma complications
Classification of injuries

- Concussion
- Subluxation
- Luxations:
  - Extrusion
  - Intrusion
- Lateral luxation
- Exarticulation
Progressive resorption

Prevalence following tooth trauma

- Concussion 0%
- Subluxation 0%
- Lateral luxation 4%
- Extrusion 6%
- Exarticulation and replantation 40%
- Intrusion 64%

(Andreasen et al. .94)
FREQUENT OBSERVATIONS! EARLY INTERVENTION!

Surface Resorption

Replacement Resorption → ankylosis

Inflammatory Resorption -granulation tissue
1. Fractures
2. Exarticulation
3. Post-trauma complications
4. Ectopic teeth
Ectopic resorption – secondary to trauma to deciduous teeth

Faculty of Dentistry, University of Oslo, Depts. of Pedodontics, Orthodontics & Prosthodontics. Stenvik & Birkeland, 2007
Ectopic resorption

Faculty of Dentistry, University of Oslo, Depts. of Pedodontics, Orthodontics & Prosthodontics.
Management

What was a common element in most of the preceding case presentations?
What was a common element in most of the preceding case presentations?

Maintain the alveolar bone!
## Diagnostic classification system of traumatic dental injuries (Ebeleseder, 1994)

<table>
<thead>
<tr>
<th>Score</th>
<th>Hard dental tissues</th>
<th>Endodont</th>
<th>Periodontium</th>
<th>Alveolar bone</th>
<th>Gingiva</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H X</td>
<td>E +</td>
<td>P +</td>
<td>A+</td>
<td>G</td>
</tr>
<tr>
<td>5</td>
<td>Intact crown</td>
<td>Intact endodont</td>
<td>Intact periodontium</td>
<td>Intact alveolar bone</td>
<td>Intact gingiva</td>
</tr>
<tr>
<td>4</td>
<td>Enamel infraction, fracture of the root apex</td>
<td>Exposure of dentine, small pulp exposure, questionable vitality</td>
<td>Concussion (inclusive minimal increase of mobility)</td>
<td>Contusion of the marginal bone</td>
<td>Contusion</td>
</tr>
<tr>
<td>3</td>
<td>Enamel-dentine fracture, intra-alveolar root fracture</td>
<td>Large pulp exposure, internal contusion (root fracture), apical contusion or rupture, successful endodontic treatment</td>
<td>Subluxation, extrusion, lateral luxation, luxation, and fracture of the alveolar process</td>
<td>Fracture of the alveolar socket</td>
<td>Rupture of the papilla</td>
</tr>
<tr>
<td>2</td>
<td>Crown-root fracture, directly restorable</td>
<td>Infection of the pulp</td>
<td>Intrusion, replantation with Fracture of the alveolar process</td>
<td>Vertical laceration</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Crown-root fracture, only indirectly restorable</td>
<td>Endodontic complications (e.g., internal root resorption,</td>
<td>Lluxation and periodontal infection</td>
<td>Fracture and infection</td>
<td>Infected laceration</td>
</tr>
<tr>
<td>0</td>
<td>Vertical fracture, lost tooth</td>
<td>inflammatory resorption</td>
<td>Replantation with necrotic periodontium</td>
<td>Loss of the alveolar socket</td>
<td>Loss of gingiva</td>
</tr>
</tbody>
</table>
Patient mediated needs

1. Esthetic requirements
2. Psychological well-being
3. Speech
4. Other
   - Space maintenance
   - Prevent muscular parafunction (tongue, swallow)
   - Chewing ability
Choice of appropriate intervention complicated by:

* Few long term studies
* New technical solutions have been introduced
* Method reported: indications, procedures, execution?
* Higher demands of aesthetics than before
Therapy alternatives for young patients with irreparable incisor(s)

Decision-tree

- **SPACE CLOSURE**
  - Remove
  - **Irreparable incisor**
  - Retain

- **Spontaneous mesial movement of posterior teeth**
- Small residual spaces are accepted
- Orthodontic space closure
- Autogenous transplantation
- Prosthetics, removable or fixed
- Implants

- **Orthodontic space closure**
- Autogenous transplantation
- Removable or fixed prosthesis
- Implants

- **Good function**
- Extraction later
  - (extensive root resorption and/or ankylosis and infraocclusion)
Rule #1

It is necessary to make an individual treatment plan for each patient.
Rule #2
General Rules do not apply
Rule #3
The management at the early phase will determine the long term outcome.
Crown–root fracture

1. Removal of coronal fragment + endodontics + orthodontic extrusion $\rightarrow$ temporary crown
2. Extraction and surgical repositioning $180^\circ$ endodontics $\rightarrow$ temporary crown
3. **Avoid extraction if possible**

Root fracture

1. Observe (apical:middle:cervical third?)
2. If communication, or signs of inflammation, remove coronal fragment + endodontics + orthodontic extrusion $\rightarrow$ temporary crown
3. **Avoid extraction if possible**
## Replace the exarticulated tooth

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Buy time!</td>
<td>➢ Frequent controls and follow-up examinations</td>
</tr>
<tr>
<td>➢ Retain bone</td>
<td></td>
</tr>
</tbody>
</table>
Bone loss following tooth extraction

Before 1 day 1 week 1 month 2 months 3 months 4 months 8 months 12 months
after

+ unknown damage of the buccal bone plate?

Lam, 1960
Replace the exarticulated tooth

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Buy time!</td>
<td>➢ Frequent controls and follow-up examinations</td>
</tr>
<tr>
<td>➢ Retain bone</td>
<td></td>
</tr>
</tbody>
</table>

**EXCEPTION:**

IF PATIENT < 12 YEARS OLD:

CONSIDER AUTOTRANSPLANTATION
Auto-transplantation

"The transplantation of embedded, impacted or erupted teeth from one site to another in the same individual into extraction sites or surgically prepared sockets"
Autotransplantation and prognostic variables

Intrinsic factors
- Root development of donor tooth
- Size of apical foramen
- Timing of orthodontic intervention
- Surgical technique

Clinical experience
- Trauma to the periodontal ligament and root-resorption (Andreassen et al. 90)
- Eruption and growth of the alveolar process (Paulsen et al. 98)
Autotransplantation of (1\textsuperscript{st}.) premolars with incomplete root formation to anterior maxilla

* > 90 % success
* New periodontal membrane
* Continuous root formation
* Pulp obliteration
* Keep alveolar process
* Keep functional occlusion
<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy time!</td>
<td>Risk of:</td>
</tr>
<tr>
<td>Retain bone</td>
<td>Infection?</td>
</tr>
<tr>
<td>Symmetry maintained</td>
<td>Pulp necrosis</td>
</tr>
<tr>
<td></td>
<td>Ankylosis</td>
</tr>
<tr>
<td></td>
<td>Infraposition</td>
</tr>
<tr>
<td></td>
<td>Ridge disharmony</td>
</tr>
<tr>
<td></td>
<td>Soft tissue disharmony</td>
</tr>
<tr>
<td></td>
<td>Inflammatory resorption</td>
</tr>
<tr>
<td></td>
<td>Discoloration</td>
</tr>
</tbody>
</table>
The exarticulated tooth – replanting the tooth and potential risks?
The exarticulated tooth

Knowledge of oral health professionals of treatment of avulsed teeth


Abstract - The management and immediate treatment of an avulsed permanent tooth will determine the long-term survival of the tooth. The aim of this study was to evaluate the knowledge of oral health professionals on the new guidelines for emergency treatment of avulsed teeth. A 12-item questionnaire was distributed among general dentists, specialists, dental hygienists and dental assistants attending Continuing Education courses at the School of Dentistry, University of Southern California, between 2003 and 2001. This study reports only on the general practitioners who comprised 83% of the participants. The results revealed an uneven pattern of knowledge among them regarding the emergency management of an avulsed tooth. Statistically significant associations were related to the participants’ previous dental trauma guidelines for replantation.

AAE and IADT advise not to replant an exarticulated permanent tooth in every case:
- extensive caries
- severe root damage
- open apices that remained in dry conditions >1 h.

Many dentists replant a permanent tooth in every case.
Is Ankylosis the biggest concern?
Ankylosis

Treatment ASAP
Alternative A, Decoronation
Ankylosis - Alternative A, Decoronation
Ankylosis - Alternative A, Decoronation
Ankylosis - Alternative A, Decoronation

Cohenca & Stabholz, 2007
Ankylosis

Treatment ASAP
Alternative A, Decoronation
Alternative B, Surgical block osteotomy
Ankylosis- Alternative B. Surgical block osteotomy

Faculty of Dentistry, University of Oslo, Depts. of Pedodontics, Orthodontics & Prosthodontics.
Ankylosis

Treatment ASAP
Alternative A, Decoronation
Alternative B, Surgical block osteotomy
(Alternative C, Intentional extraction & repositioning)
Ankylosis

Treatment ASAP
Alternative A, Decoronation
Alternative B, Surgical block osteotomy
(Alternative C, Intentional extraction & repositioning)
(Alternative D, Distraction Osteogenesis (adults))
Ankylosis – decoronation on a young patient

- 11-year + 3 y.
- Decoronation + 3 y. shows vertical bone coronal
- Vertical dimension of the alveolar process preserved
- Root proportionally moves apically.
- Horizontal bone defect and partial space closure remains
- Bone augmentation need

Schwarz-Arad, 2004
Ankylosis – decoronation on a older patient

Filippi et al., 2001
Biggest concern is lost tissues
How to restore in the anterior maxilla
Alternatives

FIRST:
Consider consequences of interventions in the mixed dentition with regard to jaw development and establishment of the permanent dentition
Growth

Planes:
- Sagital
- Frontal
- Transversal

Growth:
- Horizontal
- Vertical
Growth in time

Hand–wrist radiograph indicators can be used to place a patient in the general area of the growth curve.
Maxillary growth- horizontal plane

Transversal: mainly via the midpalatal suture.
- 3x posterior vs anterior
- 16:26 width less due to adaptive changes within the dental arch.

Length: sutural growth and bone apposition at the tuberosities
- frontal part rel. stable

Op Heij, et al. 2003
Maxillary growth - sagittal plane

Vertical development from age 4 to adulthood: Sutural and appositional growth of the dentoalveolar complex combined with tooth eruption.

Sutural growth (Su), average 11.2 mm (varying from 9.5 to 13 mm)
Resorptive lowering (Re) of the nasal floor, average 4.6 mm associated with appositional growth at the palatal side
Appositional increase in alveolar height (A), average 14.6 mm (varying from 9.5 to 21.0 mm)
Bone apposition at the orbit floor (O)

Björk & Scheller, 1977
Maxillary growth- sagital plane

An early placed implant (e.g. at the age of 5), can be found in the floor of the nose after puberty, while the permanent teeth have further grown down 15 mm.

Op Heij, et al. 2003
Mandible growth - horizontal plane

Lateral direction:
- Anterior: little change
- Premolar–molar region: moves laterally through bone remodeling (vestibular bone apposition, lingual resorption).

Anteroposterior direction:
- Mainly growth through condylar growth
- Increase in length of the corpus through resorption at the ventral side of the ramus and bone apposition at the dorsal side.

Op Heij, et al. 2003
Mandible growth - sagital plane

**Condyle growth**
- causes lengthening
- has no direct impact on possible implants.
- makes the corpus mandibulae undergo a limited rotation.

**Height**
- increases mainly through bone apposition at the dentoalveolar complex, especially during the tooth eruption phase and the growth at the condyle.

Op Heij, et al. 2003
Alternatives

Consider consequences of interventions in the mixed dentition with regard to jaw development and establishment of the permanent dentition

1. Orthodontic space closure
1. Orthodontic space closure

General considerations

- Morphology and dimension requirements
- Esthetics requirements
- Patient age
- Space situation
- Mid-line
- Root-cement
- Symmetry
Indicators for orthodontic solution

* Young patient
* Lack of space
* Proclined incisives
* Large lateral
* Other need for orthopedic treatment
Orthodontic process if early loss of central

* Move lateral to midline immediately
* Extract 1st deciduous molar to obtain mesial movement of 1st molar
* Deciduous canine extracted depending on angulation of canine
* Complete the orthodontic treatment early in the permanent dentition
Treatment aims with orthodontic space closure

* Symmetry with regard to midline
* Correct axial angulation
* Avoid retrusive dentition
* If class II: keep distal occlusion
* Neutral relation \( \Rightarrow \) distal occlusion
* Simple interventions if early start
* Change tooth forms after completed orthodontics
Morphology details

2 vs 5°

Gingival contour

Cervical margin height

Angulation & papilla fill

Canine width narrowed & lateral adjusted
Alternatives

Consider consequences of interventions in the mixed dentition with regard to jaw development and establishment of the permanent dentition

1. Orthodontic space closure

2. Conventional prosthodontics
Fixed "esthetic" solutions – preimplant – pre-etch-bridge era
Fixed prosthodontics and young patients

Complications

- Large risk for accidental pulp exposure
- Large risk of pulp damage due to thermic, osmotic chemical and bacterial effects
- Tooth in eruption, retention and esthetic problems
- Contour and gingival problems

Delay! Delay! Delay! Delay!
Etch bridges on young patients

- Occlusion
- Caries activity
- Preparation of teeth
- Cement
- Complications
  - Loosening (30-50% within 3-5 years)
  - Children vs adults?
  - plaque-retaining – secondary caries
  - esthetics
Etch bridges on young patients

- Seems to loosen more than for adults
  - More often problems with a dry work field?
  - Longer clinical crowns?
  - Resin attachment to enamel depend on age?
- Etch bridges that become loose is often after short time – good cement technique crucial.
- Recemented etch-bridges show higher loosening rate compared to recemented repaired etch-bridges – consider functional stresses
- Preparation of guideplanes, occlusal stops and proximale furrows increase retention but decrease reversibility of therapy
Alternatives

Consider consequences of interventions in the mixed dentition with regard to jaw development and establishment of the permanent dentition

1. Orthodontic space closure
2. Conventional prosthodontics
3. Removable flipper
Temporary Removable "Esthetic" solutions
Alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Consider consequences of interventions in the mixed dentition with regard to jaw development and establishment of the permanent dentition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthodontic space closure</td>
<td>1. Orthodontic space closure</td>
</tr>
<tr>
<td>Conventional prosthodontics</td>
<td>2. Conventional prosthodontics</td>
</tr>
<tr>
<td>Removable flipper</td>
<td>3. Removable flipper</td>
</tr>
<tr>
<td>Implant supported therapy</td>
<td>4. Implant supported therapy</td>
</tr>
<tr>
<td>(Auto-transplantation)</td>
<td>5. (Auto-transplantation)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Autotransplanted teeth</th>
<th>Implants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induce bone</td>
<td>No bone induction</td>
</tr>
<tr>
<td>Induce a gingival papilla</td>
<td>A gingival papilla has to be created (if possible)</td>
</tr>
<tr>
<td>No requirement of bone support</td>
<td>Requires three-dimensional bone support</td>
</tr>
<tr>
<td>Eruption possible</td>
<td>Eruption not possible</td>
</tr>
<tr>
<td>Can be moved orthodontically</td>
<td>Cannot be moved orthodontically</td>
</tr>
<tr>
<td>No age-related requirements</td>
<td>Limited to adults</td>
</tr>
<tr>
<td>Very good cost efficiency</td>
<td>Cost efficiency debatable</td>
</tr>
</tbody>
</table>
Alternatives

Consider consequences of interventions in the mixed dentition with regard to jaw development and establishment of the permanent dentition

1. Orthodontic space closure
2. Conventional prosthodontics
3. Removable flipper
4. Implant supported therapy
5. (Auto-transplantation)
Teeth continue to erupt

Teeth continue to erupt – 5 / 9 / 12 years postsurgery

Op Heij, et al. 2006
Consensus Conference on Oral Implants in Young Patients


Publisher: Gothia
Isbn: 9-1720-5044-6
What is the optimal age for placing oral implants in young patients?

There is no fixed chronological age for implant placement. Instead, biological age should be determined regarding growth and skeletal development which should be completed or nearly completed as assessed by different methods:

1. Longitudinal body height measurement
2. Hand-wrist radiograph

In cases of anodontia and severe oligodontia, however, oral implants may be placed before the pubertal growth spurt.
Implant therapy – delay!

5 years

Palatal position

Op Heij, et al. 2003
Implant therapy – delay!
Implant therapy – delay!
Implant therapy – delay!

Three major reasons for not placing implants in patients before growth ends:

1. The implant does not follow the growth of the alveolar ridge and will remain in an infraposition or perhaps even submerged.
2. An implant can potentially influence the normal growth of the jaw.
3. Immature bone reacts differently from mature bone. The implant may deviate from the original positional axis.
Thank you for your kind attention