Current Treatment Options Of Dental Trauma
Guidelines of the International Association of Dental Traumatology

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Dental Trauma

Contradictions in the treatment of traumatic dental injuries and ways to proceed in dental trauma research.

“Almost all treatment procedures used for dental traumas are still today not evidence-based, a fact, which makes it difficult to analyze the long-term outcome of healing and its relationship to treatment.”

(Andreasen et al 2010)

Dental Trauma

Contradictions in the treatment of traumatic dental injuries ....

Crown fractures with extensive dentin exposure represent a dominant injury in the permanent dentition. Accepted treatment philosophy is dentin coverage to prevent bacteria penetration into the pulp. Today there is, apart from deep fractures, no evidence that this treatment is necessary to protect the pulp.

(Andreasen et al 2010)

Dental Trauma

Contradictions in the treatment of traumatic dental injuries ....

In case of root fractures with dislocation, fast and optimal repositioning and rigid long-term splinting (i.e. 3 months) have been considered the principle of treatment.

A recent clinical study has shown that short-term splinting with a semi-rigid splint appears to optimize fracture healing.

(Andreasen et al 2010)

Dental Trauma

Contradictions in the treatment of traumatic dental injuries ....

Ideally, randomized clinical studies are needed in the future for selected trauma types.

For ethical reasons, it will be difficult to perform randomized studies on trauma victims!

We will therefore be forced in the future to rely on experimental animal studies supported by clinical observational studies.

(Andreasen et al 2010)

www.iadt-dentaltrauma.org

www.dentaltraumaguide.org
First-aid knowledge about tooth avulsion among dentists, doctors and lay people.

“Dentists, in comparison, have significantly more knowledge, but may need training in selection of the appropriate treatment option and handling and care of the avulsed tooth.”

Guidelines of IADT

What is new 2012?

22 World authorities on dental trauma from 14 countries:
- 3 general dentists
- 3 oral surgeons
- 6 pediatric dentists
- 9 endodontists
- 1 orthodontists

Guidelines of IADT

Available:

And as a app in AppleStore – “Dental Trauma”

Clinical Procedures

Adherence to the IADT guidelines for treatment of dental trauma may lead to more favorable outcomes when compared to cases treated without compliance to the guidelines:

- Complication rates were significantly lower than for cases treated without adherence to the guidelines.
- The Results indicate that early follow-up visits are essential to promptly treat complications.

(Bücher K et al. 2012)

Dental Trauma

Age Distribution

Two peaks in incidence
- 2 to 4 years of age
- 8 to 14 years of age

Andreasen & Ravn 1972, HayrinenöImmonen et al 1990

Dental Trauma

Prevalence

Believed that between 20 and 30% of all 18 years old have sustained injury to their teeth.

2/3 are mild such that there is no permanent damage to the teeth.

1/3 are severe enough to potentially cause a permanent damage.

Andreasen et al 1972, Forsberg & Rekhaen 1980
Prevalence and Incidence of Dental Trauma

- The trend of dental injuries seems to be stable on a high level.
- Variations largely reflecting local differences.
- Because of the complexity of TDIs, every dental clinic should have a prospective ongoing registration of number and severity of TDIs.

(Glendor 2008)

Dental Trauma

Sex differences

Previously contended to be at least 3 boys to 1 girl.
Now indications are more likely to be 3 to 2 or even 1 on 1!

Alonge et al 2001

Dental Trauma

Prevalence

If a child or teenager has very severe overjet (8 mm or more in vertical direction) then the incidence increases up to 50 – 60%.

Many contend that this group requires early orthodontic intervention to reduce the risk of trauma – has not been well confirmed in studies.

Fernberg & Tedestam 1993

Prevalence and Incidence of Dental Trauma

2 year follow-up, 416 (1/2 with history of trauma), aged 11-13 years.

History of previous trauma:
4.85 times greater odds ratio for additional trauma compared to the non-trauma group.
P = 0.005 after adjusting for incisal overjet, lip coverage and mother’s schooling.

(Ramos-Jorge ML. et al. 2008)

Prevalence and Incidence of Dental Trauma

The relationship between problem behavior and traumatic dental injury amongst children aged 7–15years old.
85 pars of age and sex matched kids, one with hx of trauma, one not. Clinical interview incl. parent. UK

The Odds ratio of having a dental injury increased 3.14 times if children have peer relationship problems (P < 0.032).
A prosocial behavior showed a tendency to have a protective effect (P = 0.064).

(ODI R. et al. 2002)

Prevalence and Incidence of Dental Trauma

The relationship between problem behavior and traumatic dental injury amongst children aged 7–15years old.
85 pars of age and sex matched kids, one with hx of trauma, one not. Clinical interview incl. parent. UK

Emotional symptoms, conduct disorder and hyperactivity behaviors were not related to dental injury (P > 0.75).

(ODI R. et al. 2002)
Education About Immediate Help After Dental Trauma

Effectiveness of dental trauma education for elementary school staff.

- Both pamphlets about first help after dental trauma and lecture supplemented by pamphlets significantly improved knowledge among elementary school staff.
- This difference held up over time of 3 months, especially for the pamphlets + lecture group.

(MacIntyre, et al. 2008)

Dental Trauma

Which teeth are most likely to be involved?
1. Central upper incisors (40 – 60%)
2. Lateral upper incisors (20-30%)
3. Lower incisors (20-30%)

Traumatic Injuries

Diagnosis of dental trauma

- Fact finding
- Clinical exam
- Radiographic exam
- Pulpal tests

Traumatic Injuries

✓ Fact finding
1. Patient's name, age, sex, address, and contact numbers and for young pt. weight.
2. Any CNS symptoms after the injury?

Traumatic Injuries

✓ CNS issues:
Meta-analysis:
- The mean prevalence of intracranial haemorrhage after mild head injury was 8% (95% confidence interval 3% to 13%) in 13 studies with 12,750 patients.
- Loss of consciousness or post traumatic amnesia occurred in 61% to 100% of patients in individual studies (most commonly 100%).

(Hofman PA et al. 2000)
**Traumatic Injuries**

✔ CNS issues:

- Glasgow Coma Scale
  - quick assessment

**Traumatic Injuries**

✔ CNS issues:

- Fluids from ear/nose.
- Loss of/or diminished conciseness.
- Situational confusion.
- Headache getting worse.
- Nausea / vomiting.
- Behavioral changes / unexplained irritation.
- Ataxia.
- Blurred vision / uneven pupils.
- Lack of concentration.
- Change in breathing.
- Difficulty of speech / slurred speech.

**Traumatic Injuries**

✔ CNS issues:

Remember:
Epidural Hematoma can be with a late onset of symptoms!
Pt. appears quite normal, then in minutes, hours or even days later symptoms appear.

**Traumatic Injuries**

✔ Fact finding

1. Patient’s name, age, sex, address, and contact numbers and for young pt. weight.
2. Any CNS symptoms after the injury?
4. **WHEN** did injury occur?
5. **WHERE** did injury occur?
6. **HOW** did injury occur?
7. Treatment elsewhere.
8. History of previous dental injuries.

**Traumatic Injuries**

✔ Fact finding

9. Is there any disturbance in the bite?
10. Do the teeth react to thermal changes, sweet or sour sensitivity?
11. Are the teeth sore to touch, or during eating?
12. Is there spontaneous pain from the teeth?

**Traumatic Injuries**

✔ Clinical Exam

Extra and intra oral observation
Extra and intra oral palpation
Note any midline deviation
  - both in appearance and in movement
Traumatic Injuries

✓ Clinical exam

Why do we take radiographs immediately after a dental trauma?

✓ To assess the situation
✓ To be able to decide on appropriate treatment
✓ To have a base line to compare to

Guidelines of IADT

What is new?
Radiographic examination for every injury, incl. crown fractures:
As a routine, several angles are recommended:
1. 90° horizontal angle, with central beam through the tooth in question.
2. Occlusal view
3. Periapical with a lateral angulations from mesial or distal aspect of the tooth in question.

Radiographs

Any time there is a suspicion of a horizontal root fracture several radiographs with different vertical angulations needs to be taken!

Traumatic Injuries

✓ Radiographic exam

All teeth and tissue possibly involved, including supportive bone.
Radiographs

What is appropriate radiograph?
- Investigate the trauma!
- Conclude on possible injuries
- Then look for more injuries!

Cone Beam CT?
- Access to.
- Radiation.
- Cost.

Which CBCT? Is there a benefit?
Effectiveness of limited cone-beam computed tomography in the detection of horizontal root fracture.
36 extracted teeth 1/2 with horizontal root fracture, dry skull, CBCT, standard and E-speed films

Cone beam CT images revealed significantly higher sensitivities ($P < 0.05$) than the intraoral systems, between those no significant differences were found.

(Kamburgu et al., 2009)

Traumatic Injuries
✓ Pulpal tests
37 teeth subluxated
- 20 none responsive to EPT immediately
- 17 responsive to EPT immediately
At follow-up:
- 6 of 20 non responsive to EPT now responsive
- 2 of 17 responsive to EPT now non responsive

(Skiller 1960)

Sensibility tests
Cold test is most effective
Place cold on incisal 1/3 if possible.
False negatives common soon after injury.
Needs to be repeated at all recall appointments!
- > At least two signs and symptoms are necessary of make the diagnosis of necrotic pulp.

Aim of Treatment in Dental Trauma
Regain or maintain pulp vitality !!!
Maintain pulp vitality!!!

Why?
- to strengthen dentinal walls
- avoid “difficult” endodontics
- prevent the pulpal canal space from becoming infected

Laser Doppler Flowmetry

Ability of LDF to record blood flow signals from vital pulp is well established.

Yet none has confirmed with histology LDF readings of a revascularization of the pulp


Conclusion

LDF reading correctly predicted the pulp status (vital vs. non-vital) in 83.7%

Confirmed by a histological observation of the same teeth:
(73.9% vital, 95% non-vital)

(Yampiset et al. 2001 and Ritter et al. 2005)

Conclusion

Laser Doppler Flowmetry could indicate revascularization in teeth as early as 2 to 3 weeks after the trauma.

Laser Doppler Flowmetry could confirm permanent pulpal necrosis after avulsion in 2 to 3 weeks after the trauma.

(Yampiset et al. 2001 and Ritter et al. 2005)

Crown Fractures

The main focus in the treatment of crown fractures in young permanent teeth is to maintain the vitality of the pulp.

Dental Trauma Crown Injuries

Types of trauma:
- Crown infraction
- Uncomplicated crown fracture
- Complicated crown fracture
- Uncomplicated crown-root fracture
- Complicated crown-root fracture
Crown Fractures

Crown Infraction

Clinical Presentation

Craze lines

“Use fiber optic light”

Crown Infraction

Treatment:

Baseline Sensibility tests

Radiographs: Periapical film indicated if other signs or symptoms are present

Crown Infraction

Pulpal survival very good!

However:

If the pulp was compromised or became necrotic in the trauma it has been suggested that the craze lines in enamel could become a portal of entry for bacteria.

Crown Infraction

Follow-up

No follow-up generally needed unless associated with lux. injury or other fracture type.

Crown Infraction

Prevention of Bacterial contamination of pulp after traumatic injury

Sterile BHY

Two layers of unfilled resin

BHY with S. gordonii

Adapted from RM Love 1996

Crown Infraction

Pulpal Consequences

Necrosis

Rare ~ 0.1%
Uncomplicated Crown Fracture

Definition

Fracture of the enamel (Ellis I) or enamel and dentin (Ellis II) without pulp exposure

Incidence

Most commonly reported dental injury!!
Estimated to be up to 1/3 – 1/2 of all dental injuries

Biologic Consequences:

Minimal!!
Pulp will most likely defend itself* unless we, the dentists, mess things up!

Treatment

1. Account for tooth fragment

Uncomplicated and Complicated Crown Fracture

Treatment

1. Account for tooth fragment
2. Sensibility tests
   Sensibility tests should be done prior to any treatment!
3. Radiographic evaluation:
   - periapical,
   - occlusal,
   - eccentric,
   - radiograph of lip/cheek if skin is broken.
Uncomplicated Crown Fracture

Treatment

1. Account for tooth fragment
2. Sensibility tests
3. Radiographic evaluation
4. Esthetic repair *

* If there is not time for an esthetic repair, a glass-ionomer or composite bandage should be placed on the exposed dentin at the initial visit.

Uncomplicated Crown Fracture

Dentin bonding
Vs.
Ca(OH)₂ base

Uncomplicated Crown Fracture

Young human teeth (n=353):

Odontoblast numbers and dentine repair activity was more influenced by cavity variables, than of cavity filling materials or patient factors. The most important variable was the remaining dentine thickness; below 0.25mm the numbers of odontoblasts decreased by 23%, and minimal reactionary dentine repair was observed.

(I. About et al. 2001)

Uncomplicated Crown Fracture

When remaining dentine thickness was less than 0.5 mm, but not exposing the pulp, the % of viable odontoblasts was found to be: calcium hydroxide (100%), polycarboxylate (82.4%), zinc oxide eugenol (81.3%), composite (75.5%), enamel bonding resin (49.5%)

(I. About et al. 2001)

Uncomplicated Crown Fracture

Human teeth, 3-89 days

Remaining dentine thickness mediates a powerful influence on underlying pulp tissue vitality.

A remaining dentin thickness of 0.5 mm or greater is necessary to avoid evidence of pulp injury

(Murray et al. 2003)

Uncomplicated Crown Fracture

Aim: To quantify the effect of dentine-bonding agents on Substance P (SP) release in healthy human dental pulp tissue.

Dentine-bonding agents placed over Class V cavity preparations increased SP release. One-step dentine-bonding agents increased SP release most

(Caviedes-Bucheli et al. 2010)
Uncomplicated Crown Fracture

Treatment
4. Esthetic repair.

If it is estimated that there is more than 0.5 mm into the pulp then there is no need for additional pulpal protection!

Dentin Bonding of Fragments

The key is to get the best approximation possible:
- Etch and dry (don’t over dry!!) both pieces
- Use minimal bond and no Ca(OH)$_2$ coverage if remaining dentin on the pulpal side is > 1mm
If pulpal coverage is less than 0.5 mm then Ca(OH)$_2$ coverage over the deepest part and the corresponding area of the broken piece has to be dimpled appropriately.

Dentin Bonding of Fragments

Fragment dehydration for 48 h. caused a significant reduction in fracture strength; was recovered by a 30-min rehydration.

(Capp, CI. et al. 2009)

Uncomplicated Crown Fracture

Follow-up
6-8 weeks and 1 year
Incl: Sensibility test and Radiographic evaluation

Uncomplicated Crown Fracture

Pulpal survival in a retrospective human study:
- Little pulpal response to crown fracture and subsequent restorative procedures as long as there was no concomitant periodontal injury (15-year follow-up).
- Approximately every fourth resin composite filling was rated as unacceptable at clinical examination (esthetic and/or functional).

(Robertson 1998)

Complicated crown fracture

Definition
Crown fracture involving enamel, dentin and pulp
Complicated crown fracture

Incidence
2 - 13% of all reported dental injuries

Complicated Crown Fracture

Treatment
1. Account for tooth fragment
2. Sensibility test
3. Radiographic evaluation:
   - periapical,
   - occlusal,
   - eccentric,
   - radiograph of lip/cheek if skin is broken.

Complicated Crown Fractures

Vital Pulp Therapy
Requirements for success
1. Capping of healthy pulp
2. Bacteria tight coronal seal
3. ? Capping material ?

Vital Pulp Therapy
Requirements for success
1. Pulpal Status
   Healthy pulp - success > 90%
   Inflamed pulp - success < 30%

Complicated Crown Fractures

Biologic Consequences
1st 24 to 48 hours - minimal inflammation of 1-2 mm and pulpal proliferation
Necrosis certain if no treatment

Vital Pulp Therapy
Requirements for success
2. Bacteria tight seal

Cox CF et al:
Biocompatibility of various surface-sealed dental materials against exposed pulps.
Vital Pulp Therapy
Requirements for success
? Capping material?
Bonded resin:

Animal studies on non-inflamed pulp encouraging.
Healthy human pulps not consistent results.
- Delayed healing
- Lingering inflammatory infiltrates
- Foreign body responses

(Hebling et al. 1991, Gwinnet and Tay 1998,

Complicated Crown Fracture
Review paper
Based on available data, pulp capping with resin-based composites may be said to be promising, but more and long-term research is mandatory before the method can be recommended.
(AH Schuurs et al. 2000)

Complicated Crown Fracture
Human teeth, 40 days
Scotchbond Multi-Purpose Plus may cause inflammatory changes when applied directly to exposed pulp tissue.
Direct capping with Dycal with subsequent sealing with Scotchbond Multi-Purpose Plus may show favorable results in pulp tissue.
(Subay and Demirci, 2005)

Complicated Crown Fracture
Sheep and human teeth 7 and 90 days
At 7 days, severe inflammatory responses underlying the bonding agent and in the coronal pulp were observed with soft tissue disorganization in both groups capped with Prime&Bond.
All of the teeth capped with Ca(OH)2 exhibited mild inflammatory reactions limited to the perforation area.
After 90 days with the bonding agent, in 3 of 9 sheep teeth, chronic inflammatory reactions were significant.
(Ersin and Eronat 2005)

In conclusion: “SBA’S should be avoided for vital pulp therapy, while Ca(OH)2 remains the capping agent of choice for mechanically exposed human dental pulp.”
(Silva et al. 2006)
Complicated Crown Fracture

Human, n=12, 1 and 30 days
Single Bond adhesive on pulpal exposures – no caries.
- A hybrid layer was seen on all walls but decreased gradually toward the area of pulp exposure.
- Light microscopy and scanning electron microscopy revealed important subclinical bond failures near the area of exposed pulp.

(Silva GA et al. 2013)

Complicated Crown Fracture

Human, n=12, 1 and 30 days
Single Bond adhesive on pulpal exposures – no caries.
Frequent gaps between the restoration and the dentin substrate;
- unpolymerized monomers,
- interface breaks with blood extravasation between the layers of the adhesive system,
- rupture of the odonto-blast layer,
- multinucleated giant cells close to the bonding agent.

(Silva GA et al. 2013)

Vital Pulp Therapy

Requirements for success
? Capping material ?
Bonded resin:
Calcium hydroxide:

Complicated Crown Fracture

Calcium Hydroxide (Ca(OH)$_2$):
Action unknown, possible due to the high pH (11-12) combined with inhibition of bacterial proliferation and effect on endotoxins.
Ca(OH)$_2$ cannot be used to treat an existing pulpitis
- it has no curative effect on inflammation,
- it does not appear to contribute Ca$^{+2}$ to the bridge formation.

Complicated Crown Fracture

After 7 days the tissue immediately under the necrotic pulpal area starts to calcify to form Dentin Bridge.
The dentin bridge will be come visible on radiograph after several weeks.

High speed diamond bur with copious water cooling
**Complicated Crown Fracture**

Direct capping:
5% NaOCl in a cotton pellet:
Causes chemical amputation of the blood coagulum
Removes the damaged pulp cells, dentin chips and other debris.
Provides hemorrhage control with minimal damage to the "normal" pulp tissue underneath.
(Cox & Hafez 2001)

**Vital Pulp Therapy**

Requirements for success
? Capping material ?

Bonded resin:
Calcium hydroxide:
Hard setting Ca(OH)2:
Bone Morphogenetic protein:

**Bone Morphogenetic Protein**

Pulp capping in dogs:
Comparison of a complex of recombinant human bone morphogenetic protein 2 and fibrin rhBMP2 in dogs:
Dentin bridge formation was observed at 1 week when pulp was treated with the complex and at 4 weeks with rhBMP2 and Ca(OH)2.
This complex can induce a large amount of dentin and enhance healing of exposed pulp.
(Ren et al. 1999)

**Bone Morphogenetic Protein**

Pulp capping in rats:
In most BMP 7 (Osteogenic protein 1) -treated specimens at 28 days heterogeneous mineralization filled the mesial coronal pulp.
Complete filling of the radicular pulp by homogenous mineralization in the mesial root; this reaction was found in 11 teeth in the BMP 7 group none of the Ca(OH)2 group.
(Six et al. 2002)
Vital Pulp Therapy
Requirements for success
? Capping material ?
Bonded resin:
Calcium hydroxide:
Hard setting Ca(OH)2:
Bone Morphogenic protein:
Mineral Trioxide Aggregate (MTA):

Mineral Trioxide Aggregate (MTA):

Mineral Trioxide Aggregate (MTA):
The antimicrobial activity:
Ca(OH)2 paste >> MTA, Portland cement, Sealapex > Dycal (did not show any inhibition)
Bacteria tested:
Staphylococcus aureus, Enterococcus faecalis, Pseudomonas aeruginosa, Bacillus subtilis
(Estrela et al. 2000)

Complicated Crown Fracture
Biodentine

Complicated Crown Fracture
Biodentine

Complicated Crown Fracture
Biodentine

Root Fracture
Definition
Fracture involving dentin, cementum and pulp

Follow-up
6-8 weeks and 1 year
Incl: Sensibility test and Radiographic evaluation
Root Fracture

Treatment
- reduce the displaced segment
- immobilize (?)
- follow-up critical

Root Fracture

Prognosis:
Pulp necrosis was found in 20%, 70% of those successfully treated endodontically and almost all of them only in coronal segment. (Zachrisson and Jacobsen 1975)

Influences on Prognosis:
1. The degree of dislocation of the coronal fragment.
2. The localization of the fracture influenced repair only slightly.
3. Somewhat increased mobility in some cases did NOT affect the longevity a tooth. (Zachrisson and Jacobsen 1975)

Recent retrospective study by Cvek et al. (2001) indicated:
- that rigid, long term splinting of root fractured teeth was not important variable in the prognosis of the tooth.
- How far the coronal segment was luxated from the root was important (and thereby possibly the reduction of the two segments).

Follow-up
4 weeks: splint removal
6-8 weeks
4 months * (if fracture in cervical area)
6 months
1 year
5 years
6-8 weeks and 1 year
All lncl: Sensibility test and Radiographic evaluation