

# Trauma - und dann?



*Praxis für Endodontologie & dentale Traumatologie*  
**Dr. Christoph Kaaden - München**



**Limitations of previously published systematic reviews evaluating the outcome of endodontic treatment**

M-K. Wu, H. Shemesh & P. R. Wesselink

Department of Endodontontology, Academic Centre of Dentistry Amsterdam (ACTA), University of Amsterdam and VU University, Amsterdam, The Netherlands

Author (year)	Country	Treatment	Estimated success (%)
Hepworth & Friedman (1997)	Canada	Retreatment	66
		Apical surgery	59
		Apical surgery with simultaneous retreatment	81
Peterson & Gutmann (2001)	USA	Resurgery	36
Lewsey <i>et al.</i> (2001)	UK	Root canal treatment	78
Basmadjian-Charles <i>et al.</i> (2002)	France	Root canal treatment	78
Niederman & Theodosopoulou (2003)	USA	Retrograde filling	77
Paik <i>et al.</i> (2004)	USA	Retreatment	70
Kojima <i>et al.</i> (2004)	Japan	Vital pulp	83
		Nonvital	79
Sathorn <i>et al.</i> (2005)	Australia	Single-visit	77
		Multiple-visit	71
Ng <i>et al.</i> (2007)	UK	Root canal treatment	75
Ng <i>et al.</i> (2008a)	UK	Root canal treatment	—
Ng <i>et al.</i> (2008b)	UK	Retreatment	77



## Der Zahnschutz im Sport – Funktion, Herstellung, Design

Björn Lang, Andreas Filippi

Ein aktiveres Freizeitverhalten und neue Trendsportarten haben in den letzten Jahren zu einer deutlichen Zunahme von Zahnumfällen geführt. Während im Profi-Sport das Tragen eines Zahnschutzes teilweise vorgeschrieben ist, fehlen Empfehlungen für den Amateur-, Schul- und Freizeitsport. Durch seltene Präsenz in den Medien ist die Akzeptanz bei Kindern und Jugendlichen gegenüber einem Zahnschutz im Sport in Europa sehr gering. Durch einen optimal angefertigten Zahnschutz kann das Zahnumfallrisiko beim Sport deutlich reduziert werden; ein Zahnverlust aufgrund schwerer parodontaler Schäden und lebenslange Folgebehandlungen sind deutlich seltener. Im vorliegenden Beitrag werden unterschiedliche Arten von Zahnschutz sowie deren Vor- und Nachteile beschrieben. Schließlich wird die Anfertigung eines individuellen Multilayer-Zahnschutzes detailliert dargestellt. Diesem sollte heute aufgrund seiner überlegenen Eigenschaften der Vorzug gegenüber anderen Designs gegeben werden.

Indizes Zahntrauma, Zahnschutz, Sportverletzungen, Prävention

### Einleitung

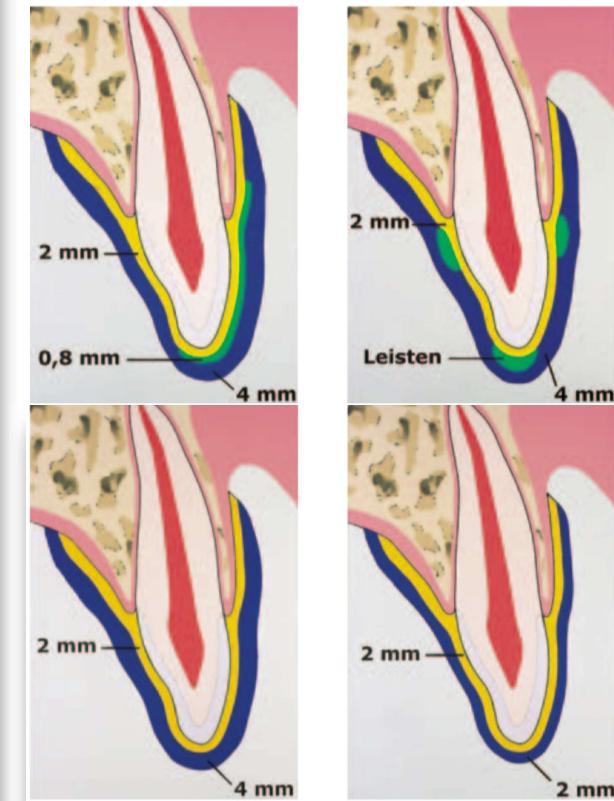
Unfallverletzungen gehören zum sportlichen Alltag. Durch ein aktiveres Freizeitverhalten und riskobehaftete Sportarten wie Mountainbiking, Rollerskating oder Skateboarding wird in den letzten Jahren ein deutlicher Anstieg sportbedingter Verletzungen und damit auch orofazialer Verletzungen beobachtet<sup>1-5</sup>. Heute erleiden bis zu 35 % aller Kinder und Jugendlichen in Europa Zahnumfälle im bleibenden Gebiss<sup>6-10</sup>; sehr viele passieren in öffentlichen Sport- und Spielstätten, in Schulen und zu Hause<sup>9, 11-13</sup>. Vor allem die Frontzähne des Oberkiefers sind durch ihre exponierte Stellung betroffen (Abb. 1); eine häufige Verletzungsart beim Sport ist die Kronenfraktur<sup>14</sup> (Abb. 2).

Grundsätzlich weisen alle Sportarten mit hohem körperlichen Einsatz ein erhöhtes Verletzungsrisiko für die Zähne auf<sup>15</sup>. Insbesondere beim Skating und Eishockey, aber auch beim Hockey, Rugby, American Football, Boxen, Handball, Lacrosse und Basketball werden sehr häufig Zahnumfälle

beobachtet<sup>15-18</sup>. Vor allem im Leistungssport sind durch den steigenden Leistungsdruck von Managern, Sponsoren und Medien immer mehr Sportler bereit, ein höheres gesundheitliches Risiko einzugehen. Aber nicht nur professionelle Sportler, denen teilweise das Tragen eines Zahnschutzes vorgeschrieben wird (Boxen, Eishockey, American Football), sondern auch Freizeitsportler sollten einen Zahnschutz tragen. Für den Amateur- und insbesondere den Freizeit- und Schulsport werden jedoch solche Empfehlungen meist nicht gegeben. Zahlreiche Untersuchungen haben gezeigt, dass Zahnumfälle durch das Tragen eines Zahnschutzes deutlich verringert werden können und er sich somit zur Prävention bewährt hat<sup>19-24</sup>. Trotzdem haben beispielsweise in den USA 10 % der Hockeyspieler an der Highschool und sogar 60 % am College bereits einen Zahn durch Trauma verloren. Bei den Profi-Hockeyspielern hat jeder Spieler sogar durchschnittlich ein bis zwei Zähne verloren<sup>25, 26</sup>. Aus Kanada kommen vergleichbare Daten: 62 % der Profi-Spieler haben einen oder

Enddate 2003; 12/1: 90-51

39





The image features a large, solid red letter 'A' positioned centrally. Around the perimeter of the letter, several dental terms are written in black text, each aligned with a specific part of the letter's outline:

- Diagnose (top left)
- Angst (top center)
- Iter (top right)
- Anästhesie (middle right)
- pikale Parodontitis (bottom right)
- natomie (middle bottom right)
- pex (bottom center right)
- Alternativen (bottom right)
- Irrigation (bottom left)
- Instrumentation (middle left)
- Obturation (middle top left)



Abwarten  
Beobachten  
Folgebehandlung  
Prädiktion  
Recall

# Healing and prognosis of teeth with intra-alveolar fractures involving the cervical part of the root

Cvek M, Mejåre I, Andreasen JO. Healing and prognosis of teeth with intra-alveolar fractures involving the cervical part of the root. *Dent Traumatol* 2002; 18: 57–65. ©Blackwell Munksgaard, 2002.

## Abstract

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### Abstract

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Received 12 January 2001  
Accepted 12 June 2001

A

B

C

D

E

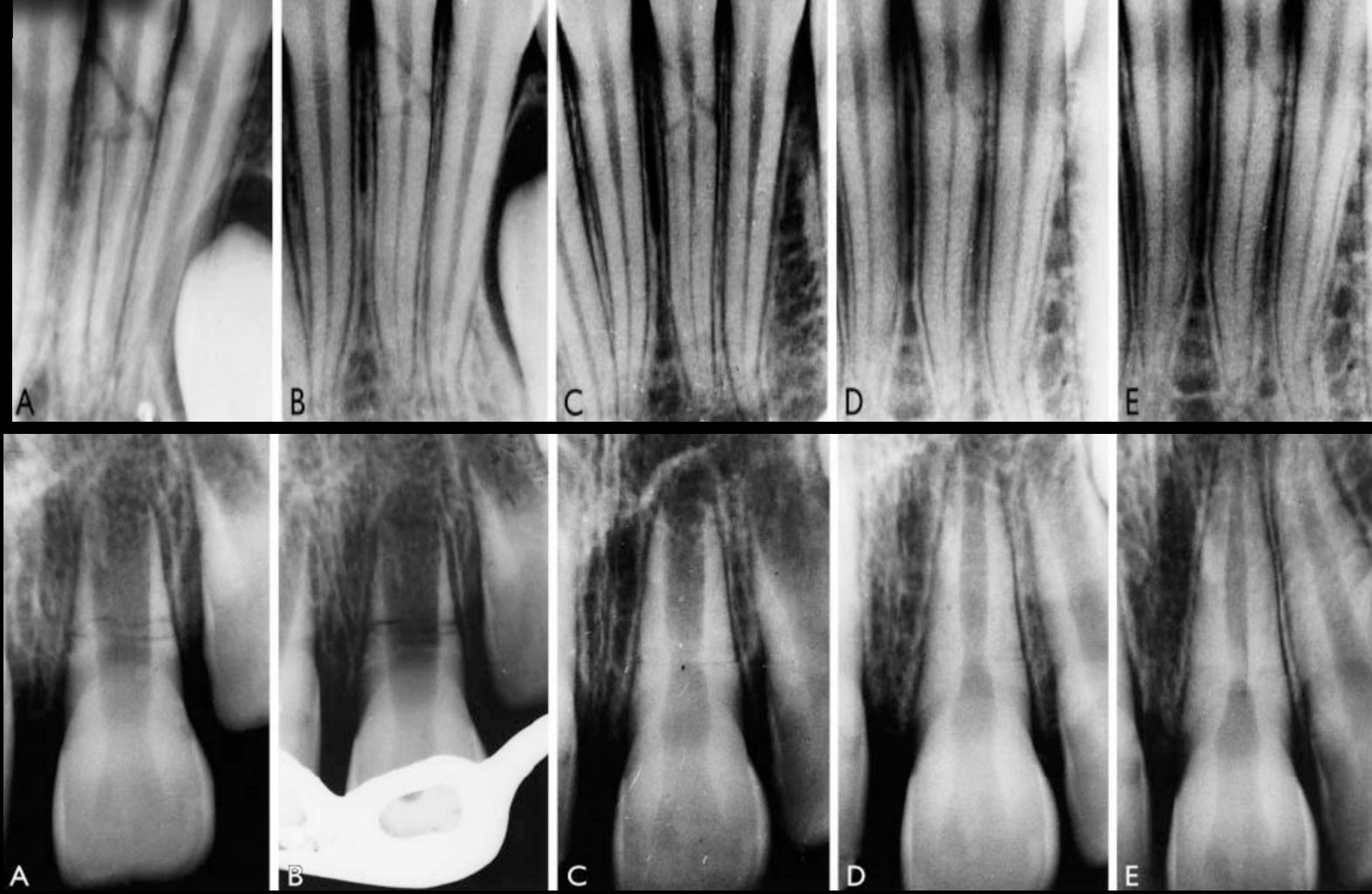
A

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C

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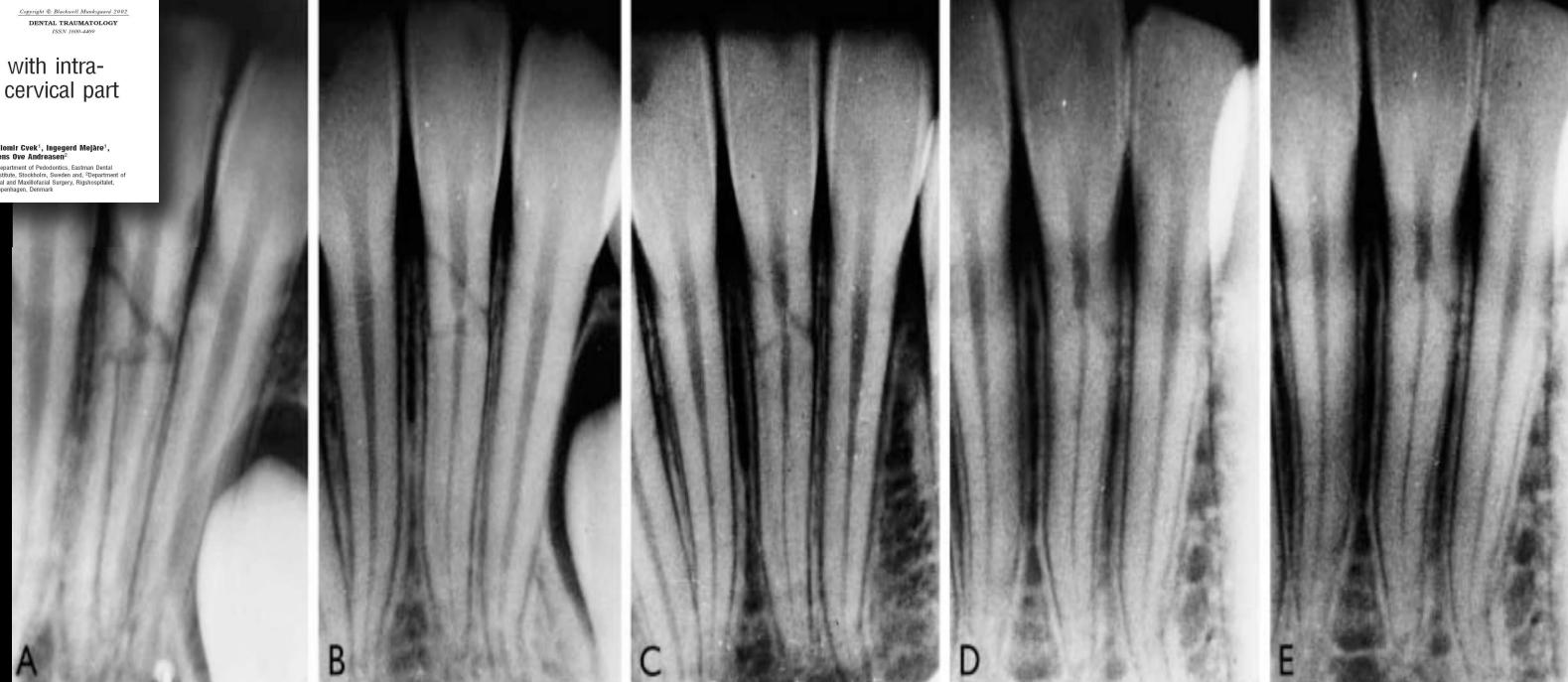


## Healing and prognosis of teeth with intra-alveolar fractures involving the cervical part of the root

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### Abstract

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coronal fragments. The type and duration of splinting (or no splinting) appeared to be of no significance for frequency or type of healing of cervical root fractures. During the observation time (mean = 75 months), 19 (44%) of the teeth with transverse fractures and 3 (8%) of those with oblique fractures were lost after healing. In conclusion, fractures in the cervical part of the root had a healing potential and the predictive parameters identified for fractures in other parts of the root seemed to be valid for the healing of cervical root fractures. Transverse fractures appeared to have a significantly poorer long-term prognosis compared to oblique fractures, apparently due to a marked post-treatment mobility, which often led to new luxation caused by even minor impacts.

[ Horizontale Fraktur ]



4 Jahre später

RVG6200

03/08

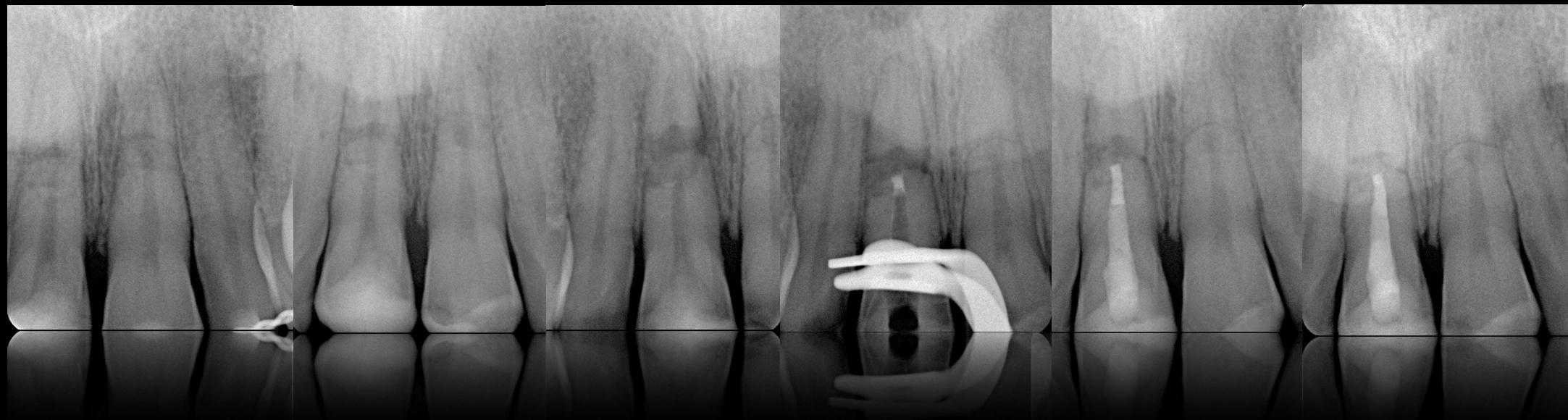
04/08

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03/09

09/09







September 2016



September 2019

## Epidemiology and outcomes of traumatic dental injuries: a review of the literature

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### ABSTRACT

Dental trauma is a significant public health problem because of its frequency, impact on economic productivity and quality of life. It is not a disease and no individual is ever at zero risk of sustaining these potentially life-changing injuries. The aim of this article was to review the literature on the prevalence, incidence, aetiology, prognosis and outcomes of dental trauma. The importance of standardized reporting, oral health policy, adjunctive research methods, prevention and education will also be discussed. A search for relevant articles appearing in databases such as Medline, Cochrane and SSCI formed the basis of this review. Epidemiological studies indicate the annual incidence of dental trauma globally is at about 4.5%. Approximately one-third of children and toddlers (primary teeth) and one-fifth of adolescents and adults (permanent teeth) sustained a traumatic dental injury. The majority involved the maxillary central incisors, mainly from falls in toddlers at home and contact sport in adolescents. Despite these trends, there is considerable variation between studies within and across jurisdictions. There is a need to standardize research with a consistent approach to reporting, classification and methodology. This will improve research and form a greater basis for predicting prognosis. This research basis will assist in consent and clinical management.

**Keywords:** Aetiology, dental trauma, epidemiology, prevalence, outcomes.

**Abbreviations and acronyms:** SCI = Social Citation Index; SH = structured histories; WHO = World Health Organization.

## Avulsion

### Relatively high risk of complications

Intrusive luxation is the most serious type of luxation injury

Risk of multiple/concurrent complications high

Prognosis also depends on age and degree of intrusion. Prognosis improves with root immaturity

Pulp necrosis is inevitable in permanent teeth. Objective is to reduce inflammatory resorption

Revascularization may be possible in immature teeth with open apex

The success rates (clinical outcomes other than pulpal necrosis) of replanted teeth achieving varying degrees of root development of immature teeth is less than 50%

Inflammatory resorption following avulsion is very common regardless of appropriate treatment

Post replantation root resorption (inflammatory/replacement) is very high

### Andreasen and Pedersen (89)

Nikoui, Kenny and Barrett (93)  
Andreasen (90)

Andreasen and Pedersen (89), Andreasen (91)

Wang (80)

Humphrey, Kenny and Barrett (94)

Trope (95)

Andreasen *et al.* (96)  
Trope (95)

Andreasen *et al.* (96)  
Trope (95)

Kinirons (97)

Kinirons (97)

Andreasen *et al.* (96) Trope (95) RR ranges from 59–80%

Donaldson and Kinirons (98)

Gonda *et al.* (99)

PN = 58%, RR = 27%, IR = 3%  
PCC = 28% (permanent dentition)

PN = 40%, PCC = 40%  
(permanent incisors)

TAB = 12.3%

PN = 85%, RR = 66%, IR = 38%,  
PCC = 4–10%,  
TAB = 0%, ANK = 24%

Almost all intruded incisors developed PN ~100% (developed roots)

Significantly decreased pulp survival if intruded over 6mm. PN ~45%

PN ~ 100% (Permanent mature teeth)

Success rates of replanted immature teeth ranged from as low as 4% to as high as 50%

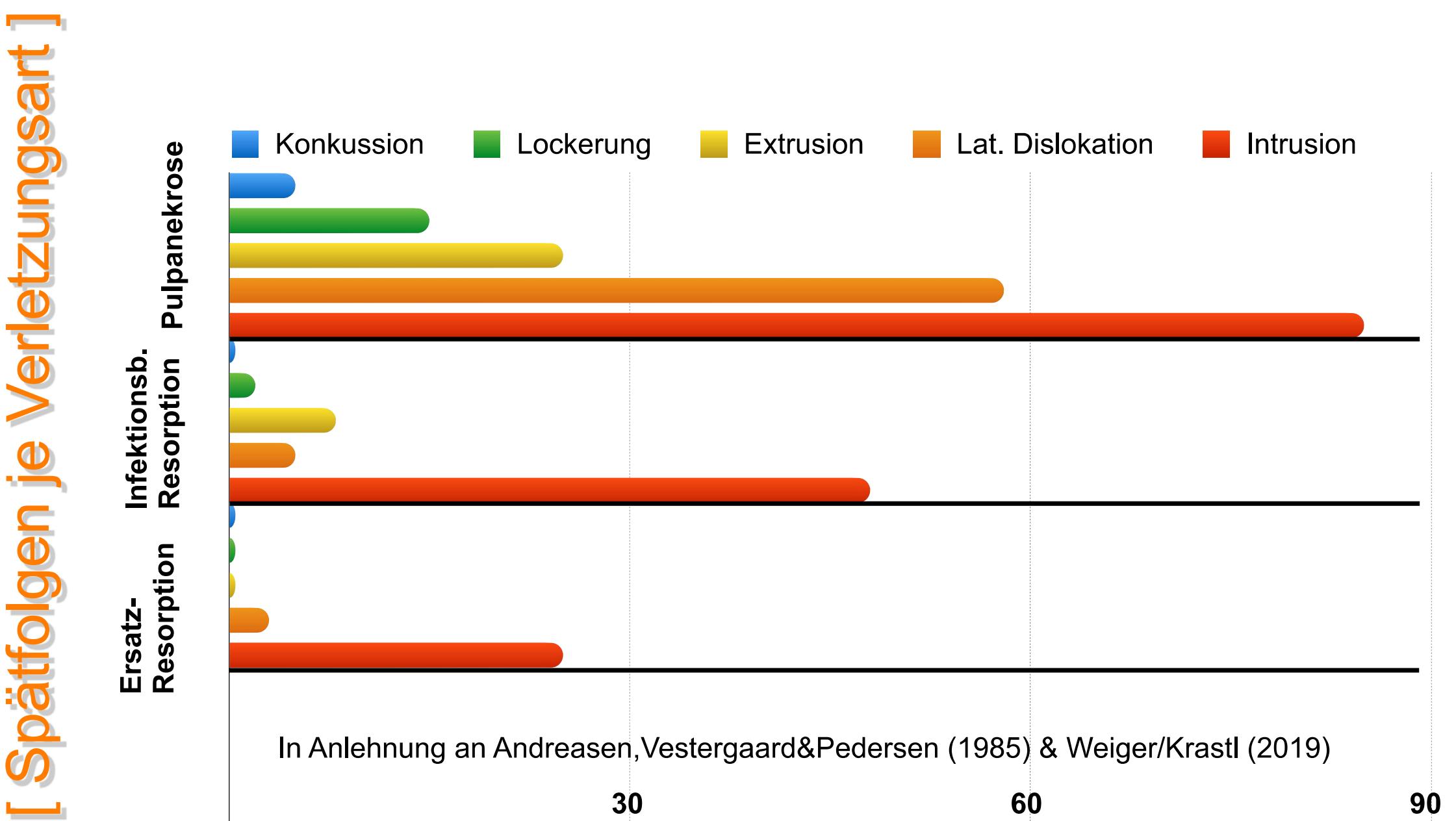
Replanted with no contamination IR~57%

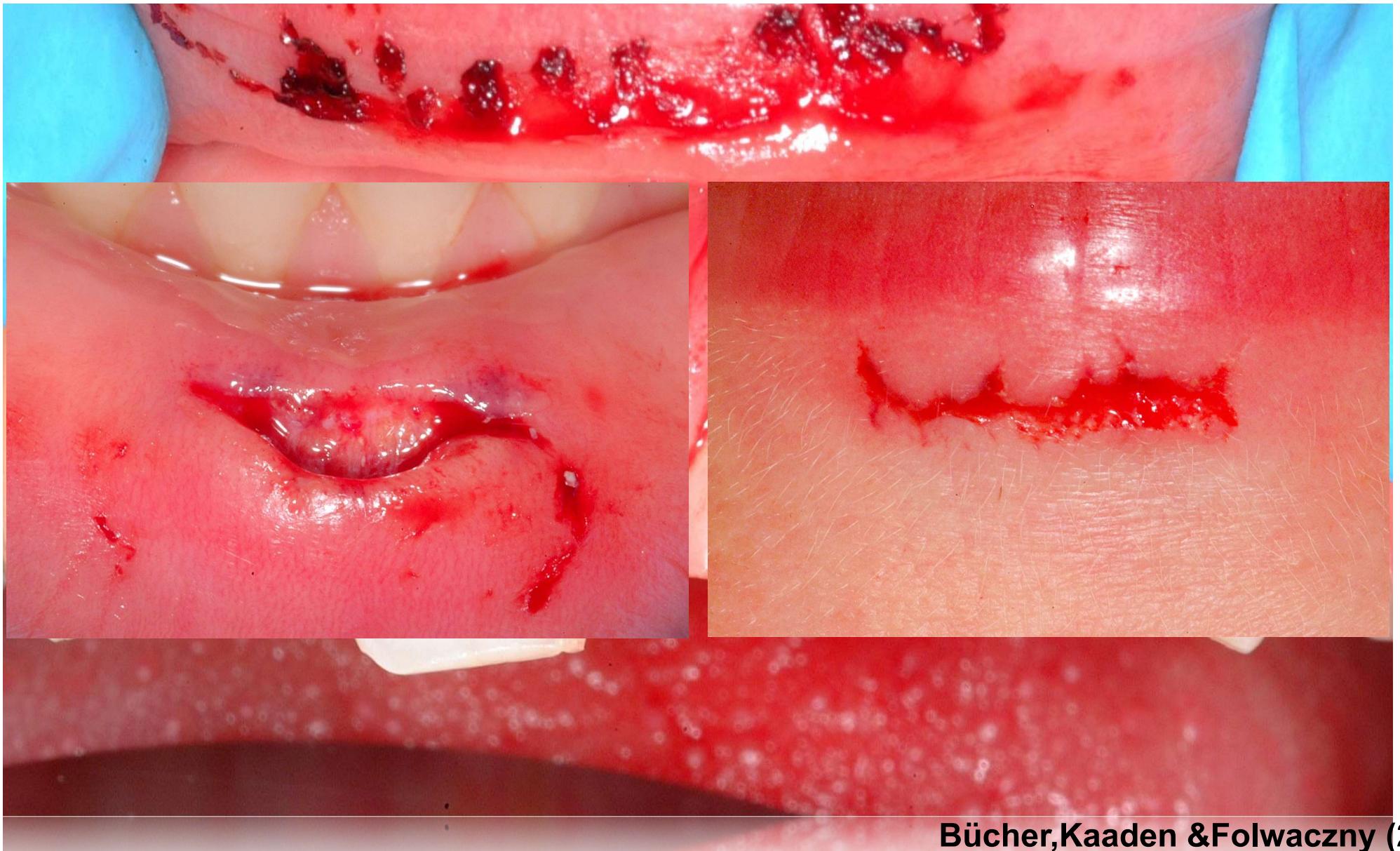
Replanted after washing contamination IR~87.5%

Replanted with contamination IR~100%

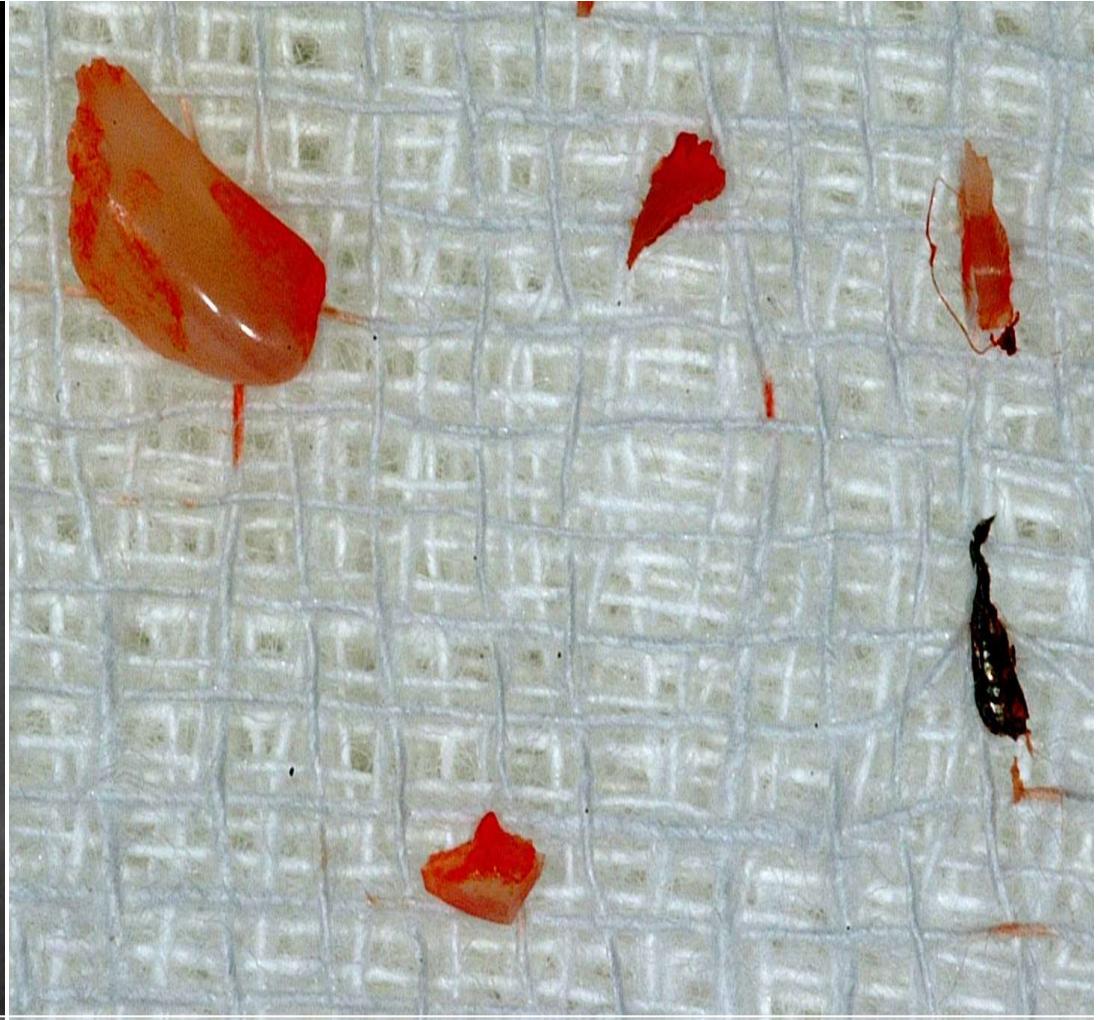
\*Median dry time was 15 minutes, patient age 7–18 years

**Key:** PN = pulp necrosis; PCC = pulp canal calcification; TAB = transient apical breakdown; RR = root resorption; IR = inflammatory resorption; ANK = ankylosis.





Bücher,Kaaden & Folwaczny (2007)



Bücher,Kaaden & Folwaczny (2007)



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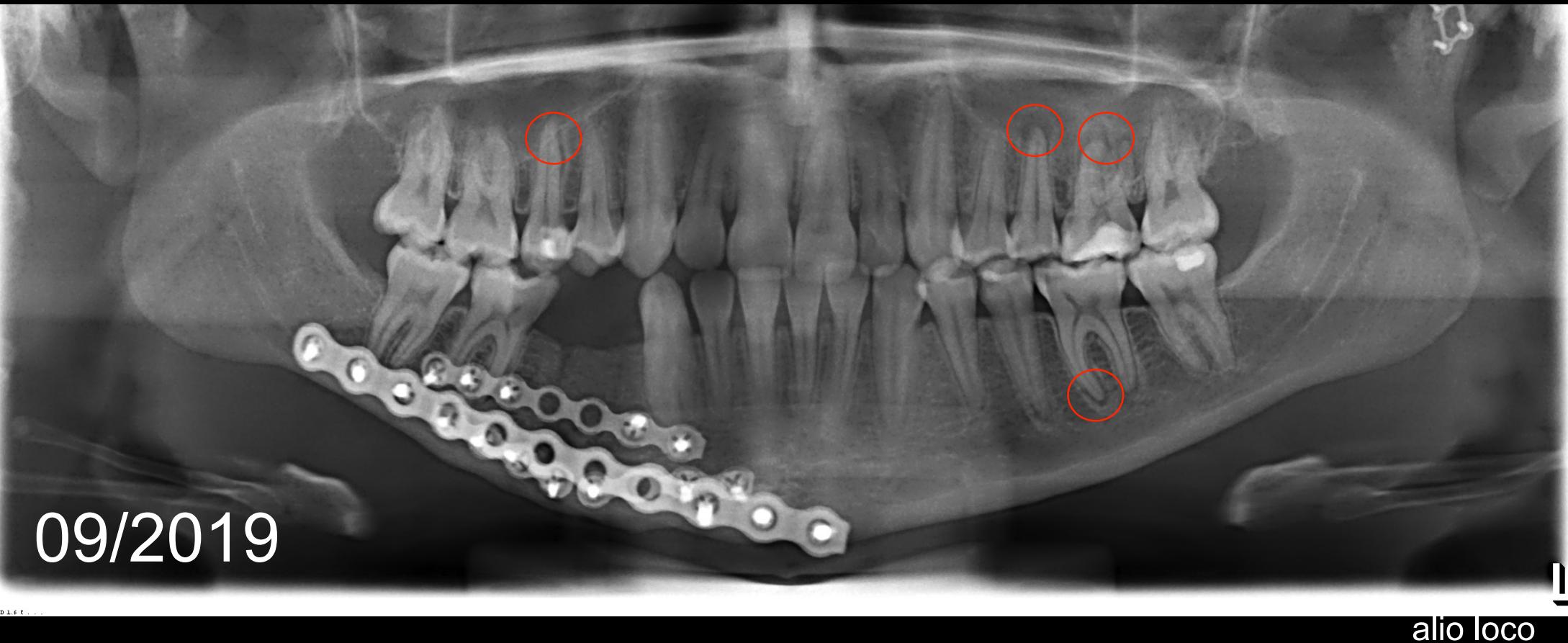


Table 4. Prognosis and outcomes of traumatic dental injuries

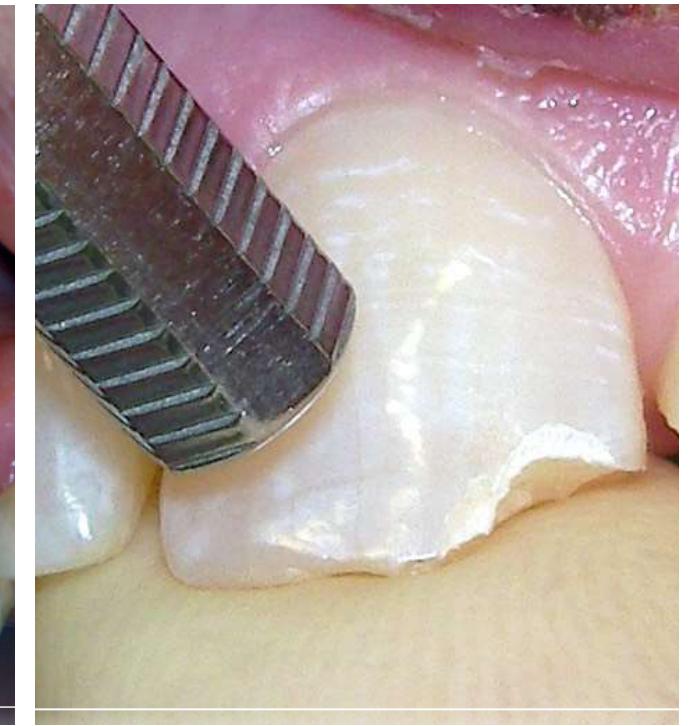
Injury type	Description/Treatment/Comments	Source (reference)	Prognosis
<b>Injuries to dental hard tissues and pulp</b>			
Enamel infraction	Generally favourable outcomes with conservative treatment	Borssen and Holm (79)	PN: 2–5%
Enamel dentine fracture	Incidence of pulpal necrosis rare Generally favourable outcomes with conservative treatment Exposed dentine tubules have a higher tendency to result in pulpal necrosis	Wang (80) Cavelleri and Zerman (81) Wang <i>et al.</i> (80)	PN: 0–3.5% PN: 5–15%
Complicated crown fracture	Outcome is case sensitive and depends on age, severity and management Losing pulp sensibility has been observed in 72% cases. Teeth treated with conservative pulp therapy methods have preserved the pulp in 98% of cases Partial pulpotomy has a higher incidence of more favourable outcomes compared to direct pulp capping <sup>3</sup> Cvek partial pulpotomy has one of the highest success rates No other concurrent injuries	Viduskalne and Care (82)  Borssen and Holm (79)  Cvek (83)  Lauridsen <i>et al.</i> (84)	PN: up to 13.7%, up to 40% without dentine protection Pulp survival 98%
Crown root fracture	Prognosis is dependent on the level of root fracture Less favourable outcome the more cervical the level of fracture The likelihood of healing by calcified tissues is poorest in the cervical third	Andreasen <i>et al.</i> (85),(86)  Welbury <i>et al.</i> (87)  Mahlotra (88)	Conservative pulp therapy without further treatment 75–95%  Cvek showed 94–96% success rates.  In the absence of a concurrent luxational injury, the prognosis of an exposed pulp is good PN: 20–40%
<b>Injuries to the periodontal tissues</b>			
Concussion	Low risk of complications. If occurred, mainly in teeth with completed root development	Andreasen and Pedersen (89), Andreasen (90)	PN = 3%, RR = 5%, PCC=5%, TAB = 1.5% (permanent dentition)
Subluxation	Low risk of complications. If occurred, mainly in teeth with completed root development	Andreasen and Pedersen (89), Andreasen (91)	PN = 6%, RR = 2%, PCC = 10–26%, TAB = 1.5% (permanent dentition)
Extrusive luxation	Moderate risk of complications	Andreasen and Pedersen (89), Andreasen (91) Lee, Barrett and Kenny (92) Andreasen (90)	PN = 26%, RR = 9%, IR = 9%, PCC=26–45% (permanent dentition) PN = 43% (permanent incisors) TAB - 11.3%

Key: PN = pulp necrosis; PCC = pulp canal calcification; TAB = transient apical breakdown; RR = root resorption; IR = inflammatory resorption; ANK = ankylosis.

3x höhere Wahrscheinlichkeit der Pulpanekrose  
ohne Versorgung der Dentinwunde (Wang et al. 2014)



# [Diagnosistik]



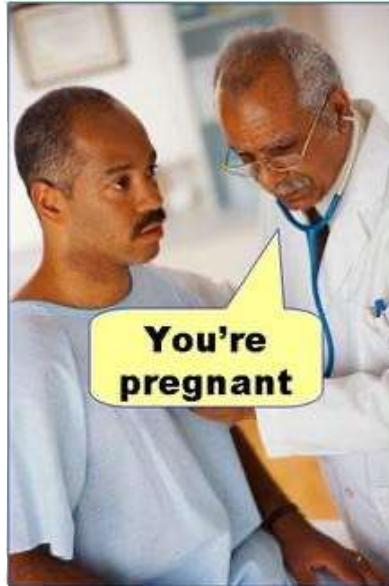
# [Diagnosotik]

- ▶ Sensibilität
- ▶ Lockerungsgrad
- ▶ Perkussion
- ▶ Taschensonsondierung
- ▶ Zahnverfärbung
- ▶ Fistelgang
- ▶ Radiologie
- ▶ Nachbarzähne !



# [Diagnosotik]

**Type I error**  
(false positive)



**Type II error**  
(false negative)



# "Fistel" ist eigentlich keine "Fistel"

(mit Epithel ausgekleidete, anomale Verbindung zwischen inneren Organen bzw. eine Verbindung zwischen zwei epithelial ausgekleideten Oberflächen),

sondern ein "oral sinus tract" (= "Höhlengang,,),  
der in 9 von 10 Fällen nur eine Auskleidung  
mit Granulationsgewebe enthält.

„Sinus tracts“ zeigt gar kein <sup>(20 von 30)</sup> bzw. nur  
teilweise <sup>(10 von 30)</sup> Epithel

►Harrison & Larson OOO 1976, Baumgartner et al. JOE 1984

## Odontogene Infektionen

Ubi pus, ibi evacua!

Ein Kurbericht von Dr. Markus Thoma, München

Odontogene Infektionen gehören zum beruflichen Alltag jedes Zahnärztes. Professor Dr. Torsten Reichen, Direktor der Klinik für Mund-, Kiefer- und Gesichtschirurgie der Universität Regensburg, referierte an die Europäische Akademie für zahnärztliche Fort- und Weiterbildung der BZK GrünH (west) in München über Therapieprinzipien und ging auf mögliche Komplikationen ein.

Der Referent betonte, dass die Behandlung odontogener Infektionen primär in die Hand des Zahnarztes gehöre, da dieser über die spezifischen Kenntnisse in der Anatomie und die zur Behandlung erforderlichen diagnostischen Techniken verfüge.

### Ursachen

Bei extraoral fistelnden Befindungen muss nach einer lokalen Entzündung gecheckt werden. Die überwiegende Zahl der entzündlichen Befindungen im Mund- und Kieferbereich ist auf Infektionen des Zahnsystems zurückzuführen. Als Ursache



können Zahnabszesse, mit Phlegmonen, die zu einer Sepsis und konsekutiv zum Tod durch Multiorganversagen führen können. Ähnlich wie sich die Ausbreitung der Entzündung ins Mediale am entzündeten Bereich weiter ausbreiten kann, kann sie auch vor einer Versiegelung der Behandlung, da sich Zahnabszesse und Phlegmonen ausbreiten, zu einem Systemversagen führen und bei Ausbreitung in den Hals zu Atemnot führen können.

**vital**

**vs.**

**devital**

**abgeschlossenes** Ø**abgeschlossenes**  
**Wachstum**                    **Wachstum**

# vital

vs.

# devital

- **Apexogenese** (**vitale** Pulpa):  
Maßnahmen zur weiteren physiolog.  
Wurzelentwicklung
- **Apexifikation** (**nekrotische** Pulpa):  
Induktion eines apikalen  
Abschlusses (durch kalzifiziertes Gewebe)

# vital

vs.

# devital

Pulpaüberkappung

- indirekt
- direkt

(part.) Pulpotomie

Pulpektomie

Pulpektomie

Apexifikation

- $\text{Ca(OH)}_2$
- MTA

Regenerative Endodontie

infektionsbedingte

R  
esorption

- ▶ Voraussetzung: Areale mit nekrotischem Wurzelzement + Infektion im Kanalsystem
- ▶ Schnell fortschreitende Resorption führt zur Zerstörung der Radix innerhalb weniger Monate

- ▶ Fehlende Reaktion auf Sensibilitätstest
- ▶ Später:
  - ▶ Erhöhte Lockerung
  - ▶ Dumpfer Perkussionsschall
  - ▶ ggf. Fistelbildung

# Röntgen

- ▶ Transluzente Zonen untersch. Größe entlang einer unregelmässigen Außenkontur
- ▶ sowohl in Wurzel als auch im benachbarten Knochen („schüsselförmige“ Resorptionslakunen)

# Therapie

► Ziel: Elimination der intrakanalären Infektion

# [ Klinisches Vorgehen ]

- ▶ 1. Med.-Einlage: Ledermix oä
  - ▶ ca. 2 Wochen
- ▶ 2. Med.-Einlage: Ca(OH)2

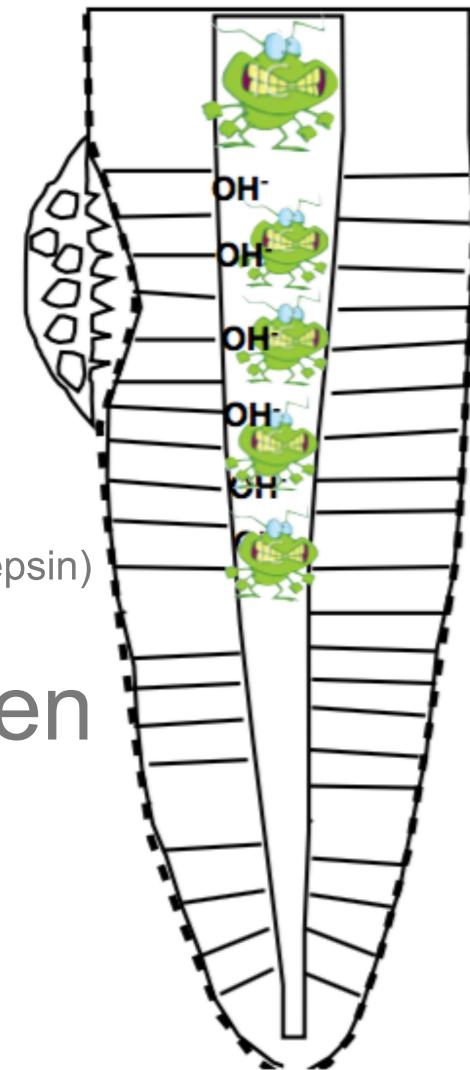
# [ Steroidhaltige Einlage? ]

- ▶ Alternative antiresorptive Einlage
- ▶ Corticosteroid
- ▶ Entzündungshemmende Wirkung
- ▶ Reduktion der Osteoklastenaktivität
- ▶ Tetrazyklin
- ▶ antibakterielle Wirkung
- ▶ Hemmung Osteoklasten/Collagenaseaktivität

## [Wirkung von $\text{Ca}(\text{OH})_2$ ]

- ▶ Antibakterieller Effekt
- ▶ Säure-Neutralisierung
- ▶ Inaktivierung saurer Hydrolysen (Cathepsin)
- ▶ Aktivierung alkalischer Phosphatasen

Krastl



externe invasive zervikale

R  
esorption

# [Ätiologische Faktoren]

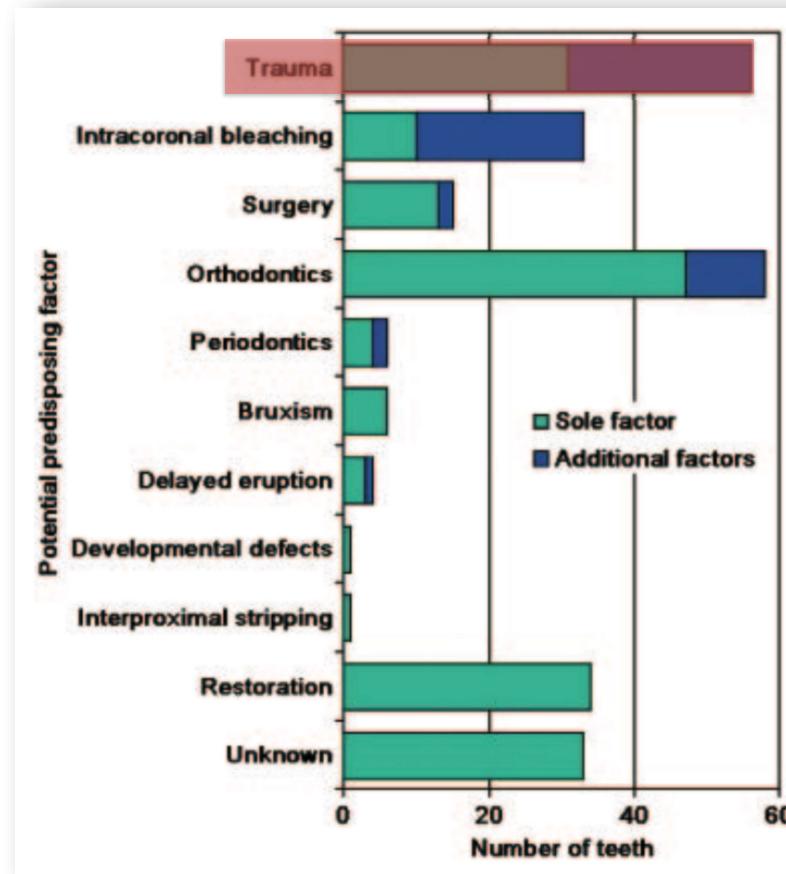


Fig. 1. Invasive cervical resorption: Distribution of potential predisposing factors for patients. From (20). Reproduced with permission from Quintessence Publishing.

# ■ Ätiologie

► Pulpales Gewebe spielt keine Rolle

# Ätiologie

- ▶ Entzündlich bedingt mit „Aktivierung“ durch sulkulär ansässige Bakterien
- ▶ Benigne fibrovaskuläre/-ossäre Proliferationsstörung mit bakterieller Suprainfektion

# Röntgen

- Pa-Spalt durchgängig
- Marmorierung & bizarre Umrissform
- Asymmetrische Lage des Defekts
- Abgrenzung Kanallumen durch Prädentin

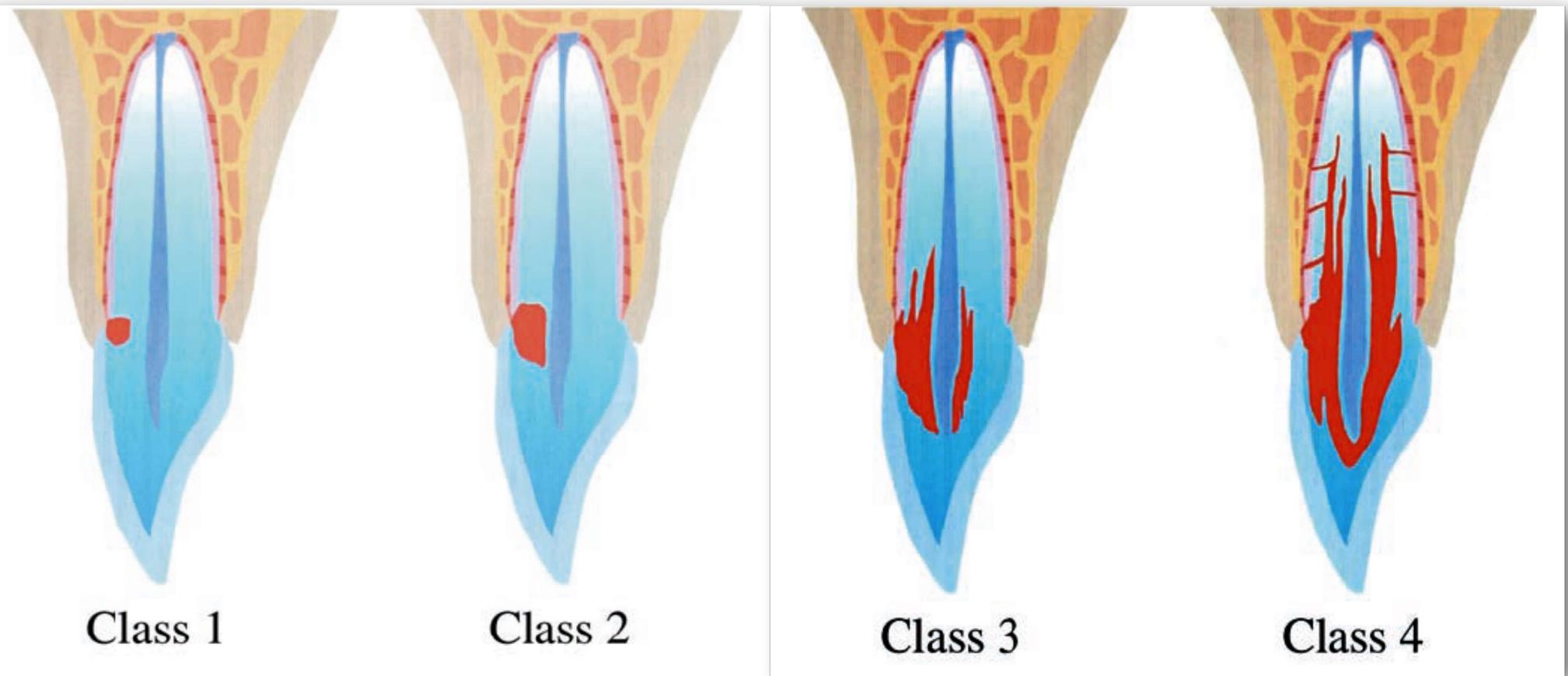
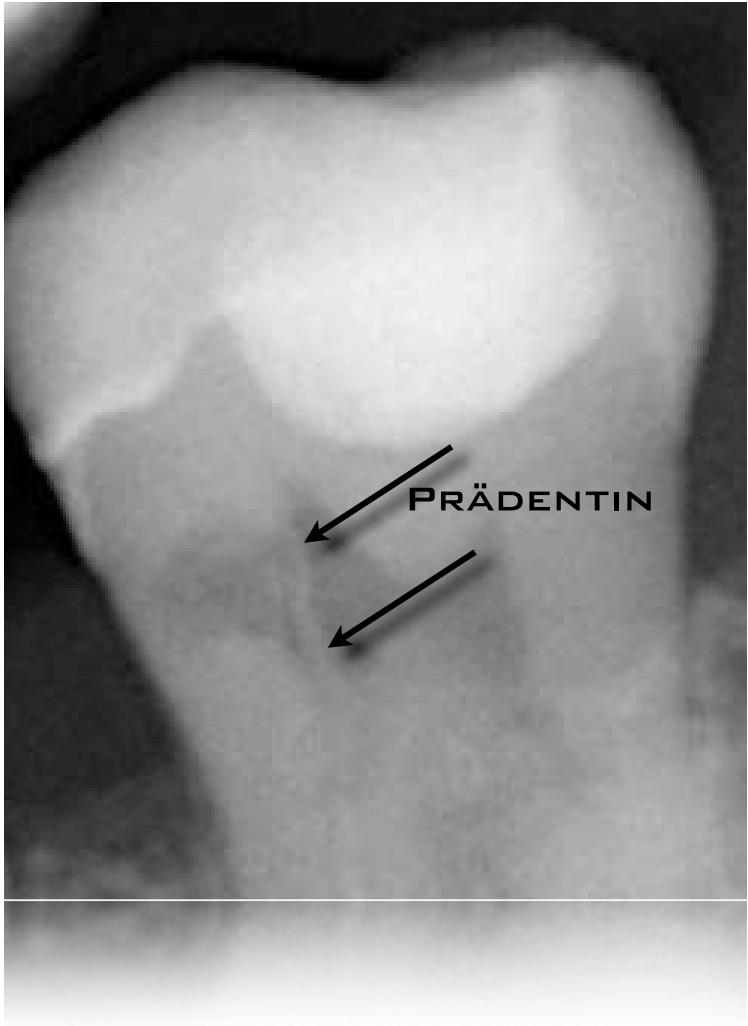


Fig 22. Clinical classification of invasive cervical resorption.  
Reproduced from Heithersay GS, Quintessence Int 1999;30:83-95,  
courtesy Quintessence International.



- Anatomische „Konfiguration“ der Schmelz-Zement-Grenze ggf. auch von Bedeutung

- Initial keine Penetration der Pulpa, da Prädentin als „Schutzschicht“ wirkt

Ersatz-

R  
esorption

## [ Ersatzresorption ]



- ▶ Falls Ankylose & Infraposition > 1mm
- ▶ Dekoronation empfohlen

# Ridge Preservation/Decoronation

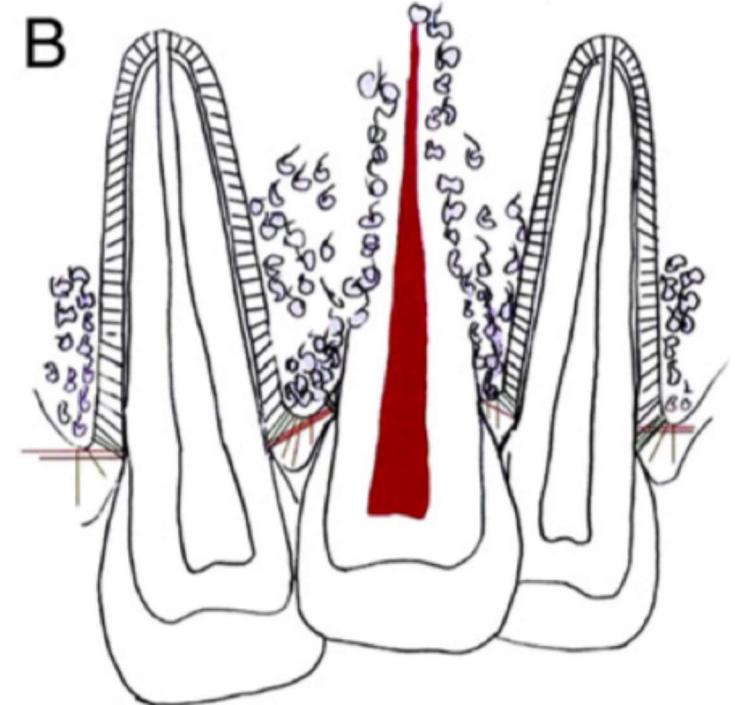
*Barbro Malmgren, DDS, PhD*

## **Abstract**

Dentoalveolar ankylosis of a tooth is a serious complication in growing individuals. The ankylosed root is continuously resorbed and replaced by bone, and an infraposition of the damaged tooth will develop. The normal alveolar development will be disrupted in this way, and prosthetic treatment will be compromised. Therefore, an ankylosed tooth should be removed before future orthodontic and/or prosthetic therapy is jeopardized. This article will present a method, decoronation, to remove an ankylosed tooth in such a way that the alveolar ridge is preserved and give guidelines for the timing to intervene. The decoronation method is described, and a possible explanation for the favorable outcome is discussed. Different aids to decide the time for intervention are presented. The alveolar ridge was maintained in buccal/palatinal direction, and the bone level increased after decoronation in patients treated before or during pubertal growth periods. The bone level also increased in those treated after this period but not at the same rate, and in a few patients it was unchanged. The clinical finding that decoronation can maintain or reestablish normal alveolar conditions is important for successful implant insertion later. (*J Endod* 2013;39:S67–S72)

# Ridge Preservation/Decoronation

*Barbro Malmgren, DDS, PhD*



## Alveolar bone development after decoronation of ankylosed teeth

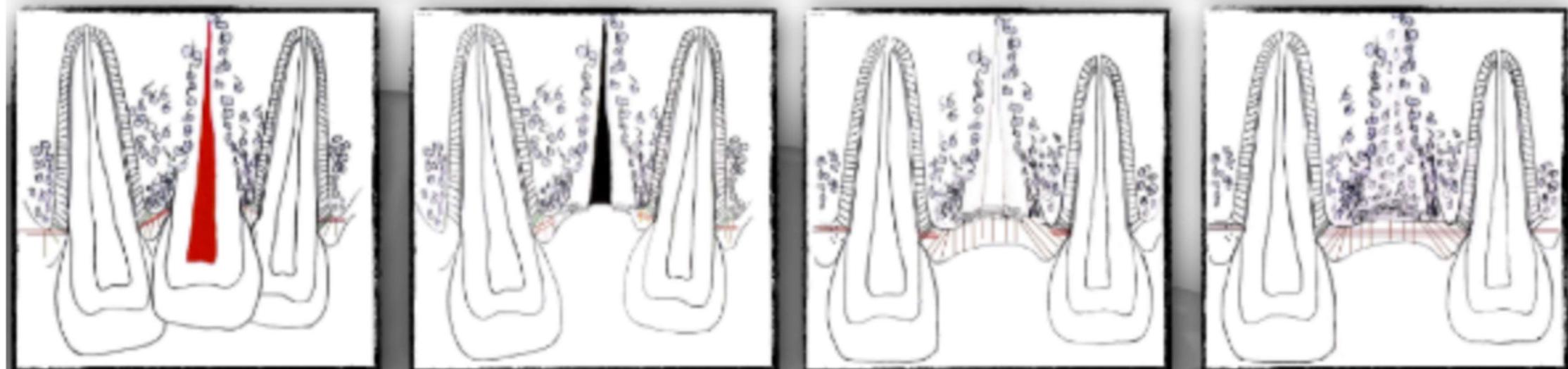


Fig. 3

Malmgren B et al., 2006



# Autotransplantation of teeth with incomplete root formation: a systematic review and meta-analysis

Evelyn C. M. Rohof<sup>1</sup> • Wouter Kerdijk<sup>2</sup> • Johan Jansma<sup>3</sup> • Christos Livas<sup>4</sup> • Yijin Ren<sup>1</sup>

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## Autotransplantation of teeth with incomplete root formation: a systematic review and meta-analysis

Evelyn C. M. Rohof<sup>1</sup> · Wouter Kerdijk<sup>2</sup> · Johan Jansma<sup>3</sup> · Christos Livas<sup>4</sup> · Yijin Ren<sup>1</sup>

Received: 31 March 2017 / Accepted: 1 March 2018  
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### Abstract

**Objectives** The objective of this systematic review and meta-analysis was to determine the rates of survival and success and the complications related to autotransplantation of teeth with incomplete root formation. Additionally, we attempted to identify the prognostic factors that influence the outcome of tooth autotransplantation.

**Materials and methods** A literature search for all data published until July 2016 was conducted. Inclusion and exclusion criteria were specified. Risk of bias was assessed with the Newcastle checklist. Meta-analysis was performed by using the DerSimonian-Laird random effect model. The 1-, 5-, and 10-year survival rates and the weighted estimated survival, success, and complication rates per year were calculated.

**Results** Thirty-two studies were included for analysis. The survival rates reported after 1, 5, and 10 years were 97.4, 97.8, and 96.3%, respectively. The annual weighted estimated survival rate (98.2%), success rate (96.6%), and complication rates in terms of ankylosis (2.0%), root resorption (2.9%), and pulp necrosis (3.3%) were analyzed. No firm conclusions could be drawn with respect to the prognostic factors due to insufficient evidence of high quality.

**Conclusion** The survival and success rates of autotransplantation of teeth with incomplete root formation were high (> 95%), with a low rate of complications (< 5%).

**Clinical relevance** Current evidence from the literature on autotransplantation of teeth with incomplete root formation shows favorable survival and success rates and low complication rates, indicating it is a reliable treatment option.

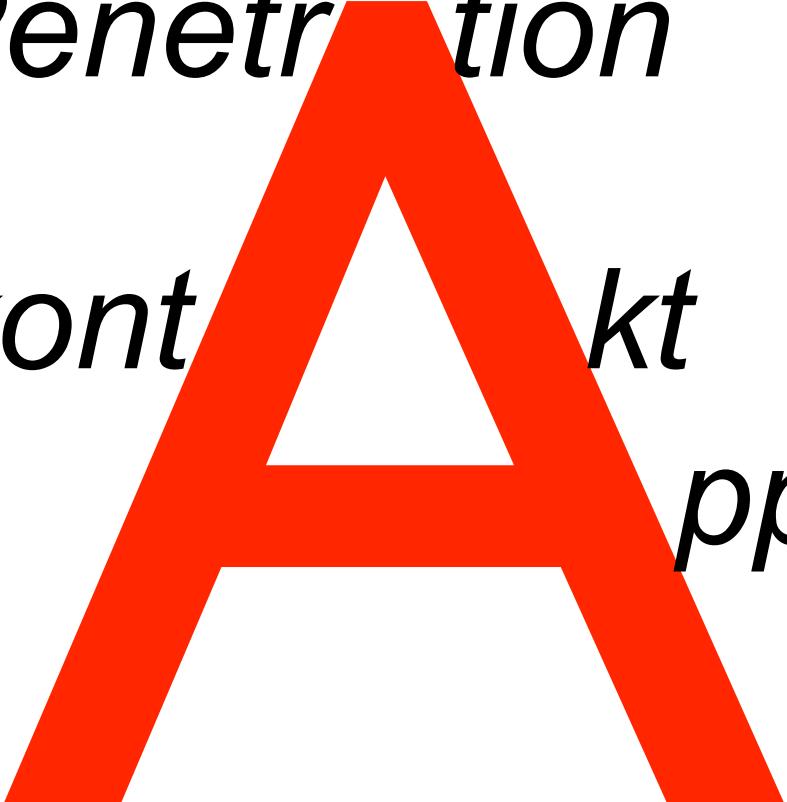
**Keywords** Tooth autotransplantation · Incomplete root formation · Success rate · Survival rate · Systematic review · Meta-analysis

*Penetration*

*Knochenkontakt*

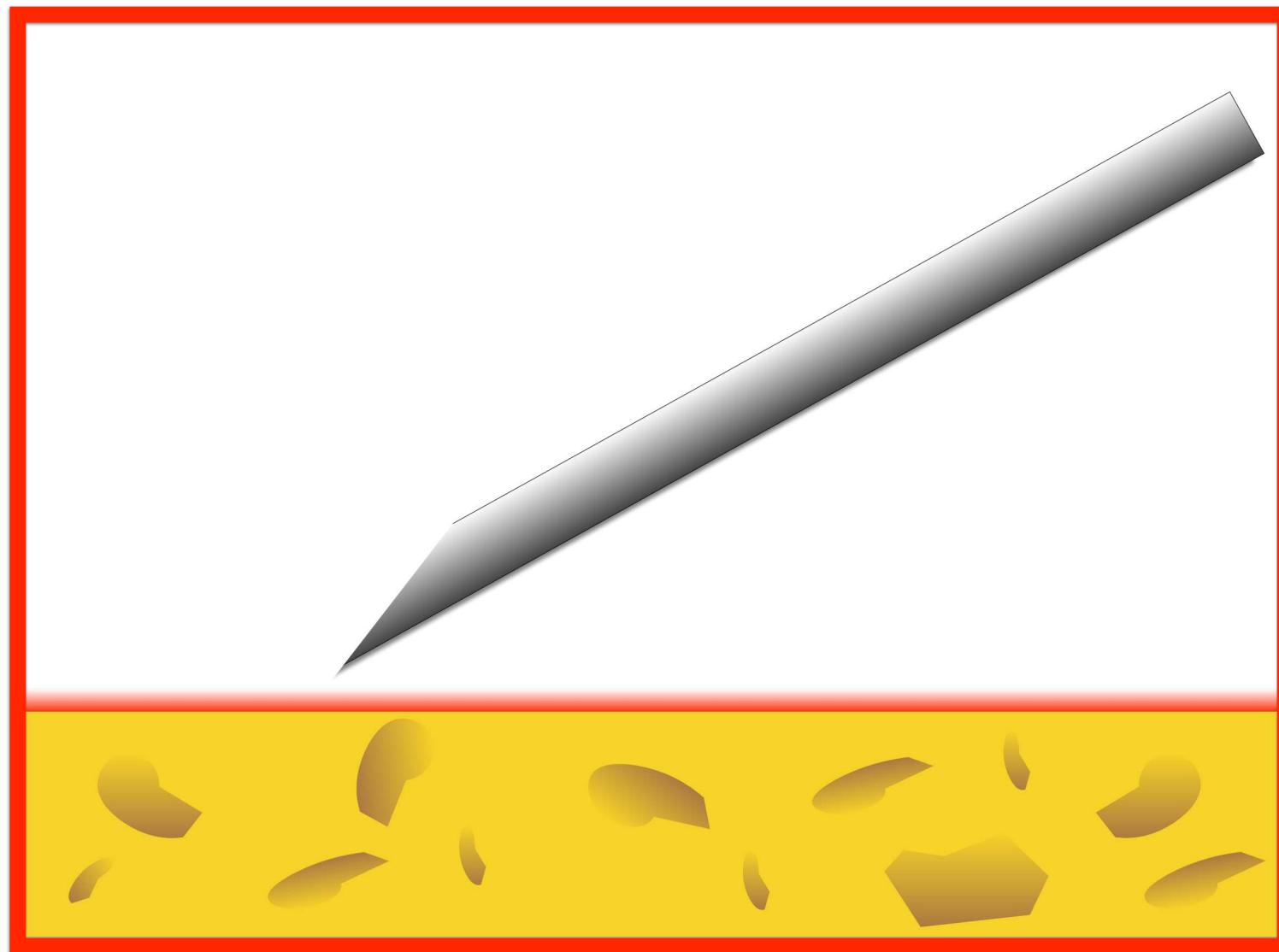
*Applikation*

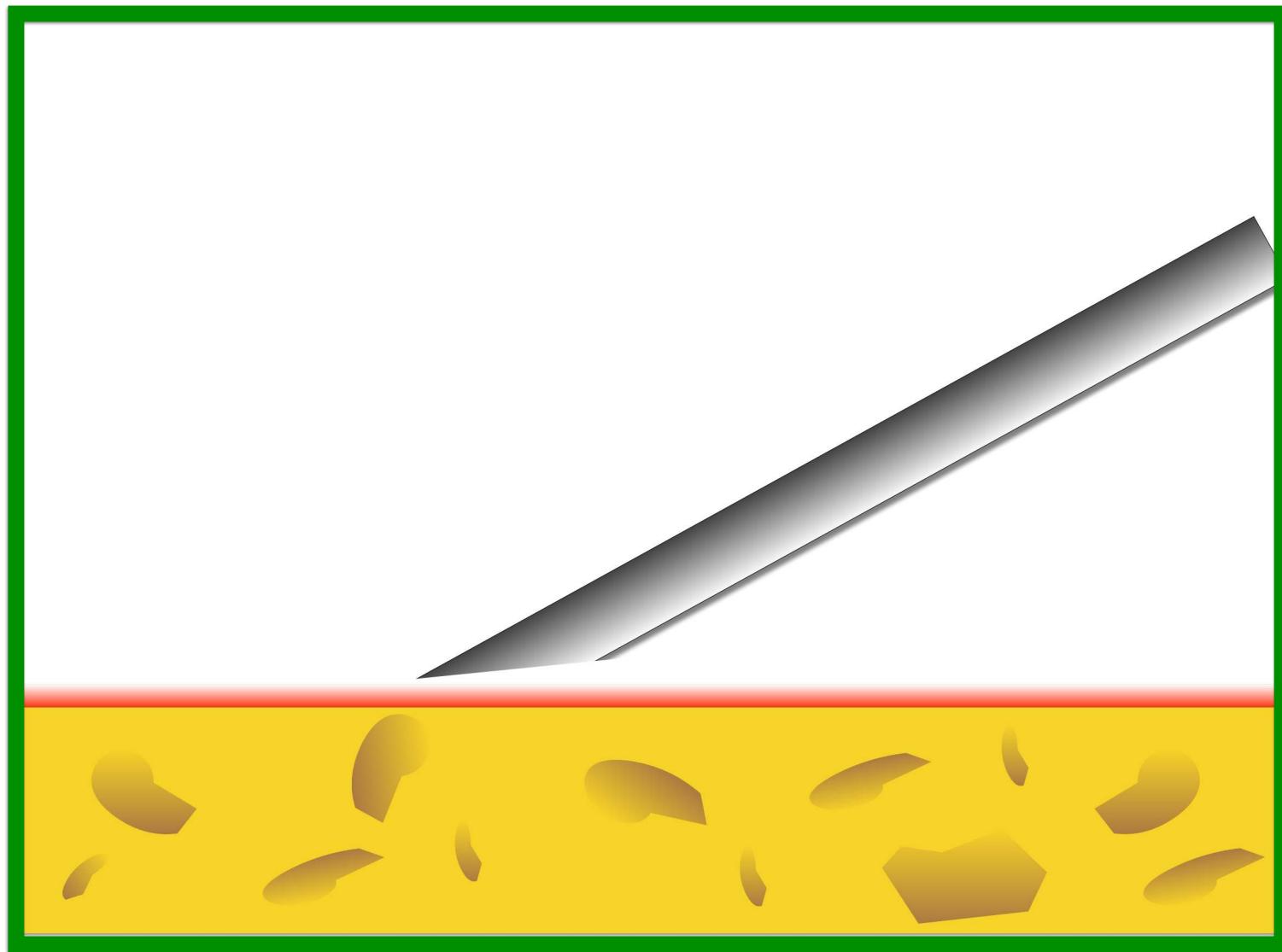
*Anästhesie*











# Speed of Injection Influences Efficacy of Inferior Alveolar Nerve Blocks: A Double-Blind Randomized Controlled Trial in Volunteers

*Mohammad Dib Kanaa, MPhil, DDS, John Gerard Meechan, PhD, BDS,  
Ian Porter Corbett, PhD, BDS, and John Martin Whitworth, PhD, BCbD*

## **Abstract**

This randomized double-blind crossover trial investigated the efficacy and discomfort associated with slow (60 seconds) and rapid (15 seconds) inferior alveolar nerve blocks (IANB) using 2.0 ml of 2% lidocaine with 1:80,000 epinephrine in securing mandibular first molar, premolar and lateral incisor pulp anesthesia in 38 healthy adult volunteers. Episodes of maximal stimulation (80  $\mu$ A) without sensation on electronic pulp testing were recorded. Injection discomfort was self-recorded by volunteers on 100 mm visual analogue scales. Data were analyzed by McNemar, Friedman, Wilcoxon Signed Ranks, and paired t tests. Slow IANB produced more episodes of no response to maximal pulp stimulation than rapid IANB in molars (220 episodes versus 159,  $p < 0.001$ ), premolars (253 episodes versus 216,  $p = 0.003$ ) and lateral incisors (119 episodes versus 99,  $p = 0.049$ ). Slow IANB was more comfortable than rapid IANB ( $p = 0.021$ ). (*J Endod* 2006;32:919–923)

	%	Wirkungseintritt (Min)	Wirkungsdauer	
			Pulpal (Min)	Weichgewebe (h)
<b>Articain</b>	4	2-3	60	3-5
<b>Lidocain</b>	2	3-5	60	3-5
<b>Bupivacain</b>	0,5	6-10	90-180	3-12
<b>Mepivacain</b>	3	3-5	20-40	2-3

Modifiziert nach Maladem (2006)

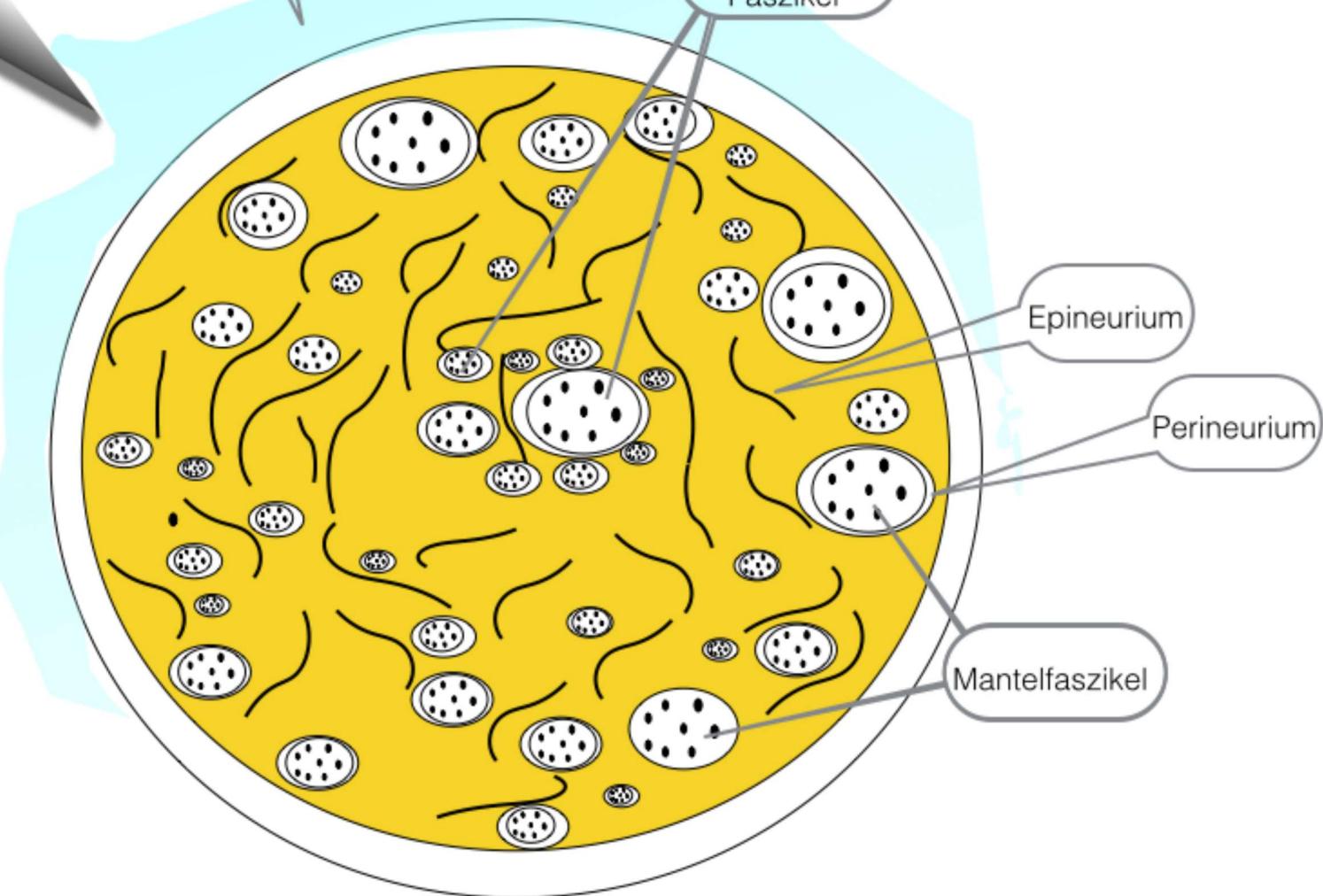
Lokalanästhetikum

zentrale  
Faszikel

Epineurium

Perineurium

Mantelfaszikel



# vital

# devital

## Pulpaüberkappung

- indirekt
- direkt

## (Partielle) Pulpotomie

## Pulpektomie

## Pulpektomie

## Apexifikation

- $\text{Ca(OH)}_2$
- MTA

## Regenerative Endodontie

**vital**

**devital**

**abgeschlossenes  
Wachstum**

**Øabgeschlossenes  
Wachstum**

# vital

Pulpaüberkappung

- indirekt
- direkt

(part.) Pulpotomie

# devital

Pulpektomie

Apexifikation

- $\text{Ca(OH)}_2$
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Regenerative Endodontie

**Table 4. Prognosis and outcomes of traumatic dental injuries**

Injury type	Description/Treatment/Comments	Source (reference)	Prognosis
<b>Injuries to dental hard tissues and pulp</b>			
Enamel infraction	Generally favourable outcomes with conservative treatment	Borssen and Holm (79)	PN: 2–5%
Enamel dentine fracture	Incidence of pulpal necrosis rare Generally favourable outcomes with conservative treatment Exposed dentine tubules have a higher tendency to result in pulpal necrosis Outcome is case sensitive and depends on age, severity and management	Wang (80) Cavelleri and Zerman (81) Wang <i>et al.</i> (80) Viduskalne and Care (82)	PN: 0–3.5% PN: 5–15% PN: up to 13.7%, up to 40% without dentine protection Pulp survival 98%
Complicated crown fracture	Losing pulp sensibility has been observed in 72% cases. Teeth treated with conservative pulp therapy methods have preserved the pulp in 98% of cases Partial pulpotomy has a higher incidence of more favourable outcomes compared to direct pulp capping <sup>3</sup> Cvek partial pulpotomy has one of the highest success rates No other concurrent injuries	Borssen and Holm (79) Cvek (83) Lauridsen <i>et al.</i> (84)	Conservative pulp therapy without further treatment 75–95% Cvek showed 94–96% success rates.
Crown root fracture	Prognosis is dependent on the level of root fracture Less favourable outcome the more cervical the level of fracture The likelihood of healing by calcified tissues is poorest in the cervical third	Andreasen <i>et al.</i> (85),(86) Welbury <i>et al.</i> (87) Mahlotra (88)	In the absence of a concurrent luxational injury, the prognosis of an exposed pulp is good PN: 20–40% PCC: 69–23% PN = 25%
<b>Injuries to the periodontal tissues</b>			
Concussion	Low risk of complications. If occurred, mainly in teeth with completed root development	Andreasen and Pedersen (89), Andreasen (90)	PN = 3%, RR = 5%, PCC=5%, TAB = 1.5% (permanent dentition)
Subluxation	Low risk of complications. If occurred, mainly in teeth with completed root development	Andreasen and Pedersen (89), Andreasen (91)	PN = 6%, RR = 2%, PCC = 10–26%, TAB = 1.5% (permanent dentition)
Extrusive luxation	Moderate risk of complications	Andreasen and Pedersen (89), Andreasen (91) Lee, Barrett and Kenny (92) Andreasen (90)	PN = 26%, RR = 9%, IR = 9%, PCC=26–45% (permanent dentition) PN = 43% (permanent incisors) TAB - 11.3%

Key: PN = pulp necrosis; PCC = pulp canal calcification; TAB = transient apical breakdown; RR = root resorption; IR = inflammatory resorption; ANK = ankylosis.

## *Review Article*

# **Clinical outcome of direct pulp capping with MTA or calcium hydroxide: a systematic review and meta-analysis**

Chenxi Zhu, Bin Ju, Rong Ni

In conclusion, based on available information at present, the results of this meta-analysis demonstrated that MTA performs superior to calcium hydroxide as a direct pulp-capping material. However, larger, blind, randomized controlled trials are needed to be conducted to provide more reliable clinical evidence.

# vital

Pulpaüberkappung

- indirekt
- direkt

(part.) Pulpotomie

# devital

Pulpektomie

Apexifikation

- $\text{Ca(OH)}_2$
- MTA

Regenerative Endodontie

# devital

## Pulpektomie

## Apexifikation

- $\text{Ca(OH)}_2$
- MTA

## Regenerative Endodontie

# devital

Pulpektomie

Apexifikation

- $\text{Ca(OH)}_2$
- MTA

Regenerative Endodontie

A

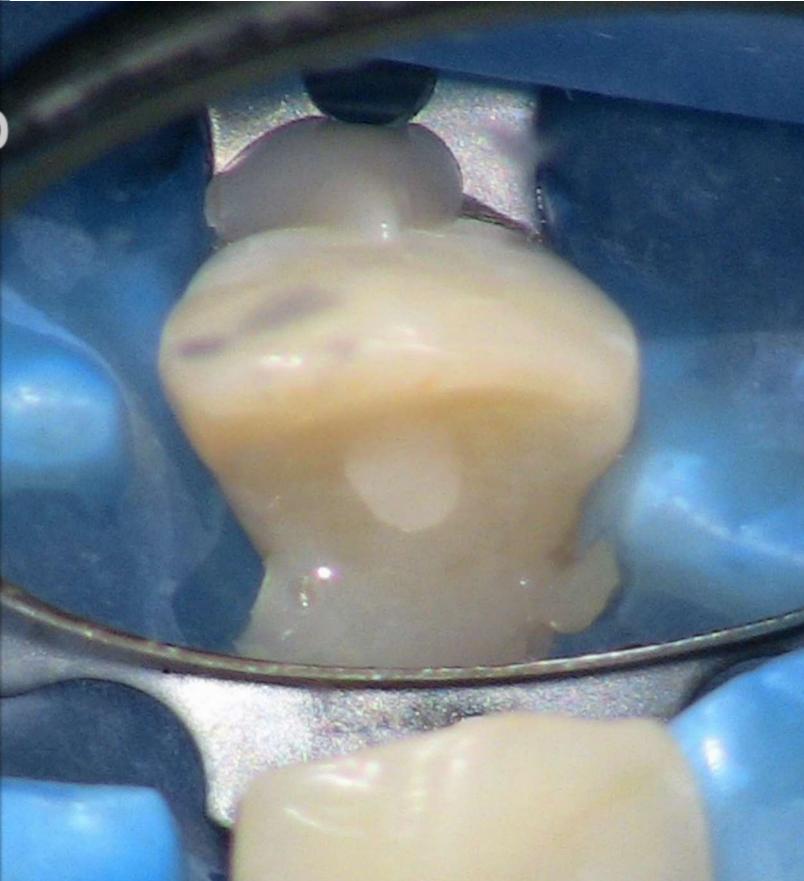
bsolute

Trockenlegung

# [ Absolute Trockenlegung ]



# Absolute Trockenlegung



Temporäre adhäsive  
Fixierung mit Rely X Unicem



Temporäre adhäsive  
Fixierung mit Rely X Unicem

# [ Absolute Trockenlegung ]



**Oraseal**



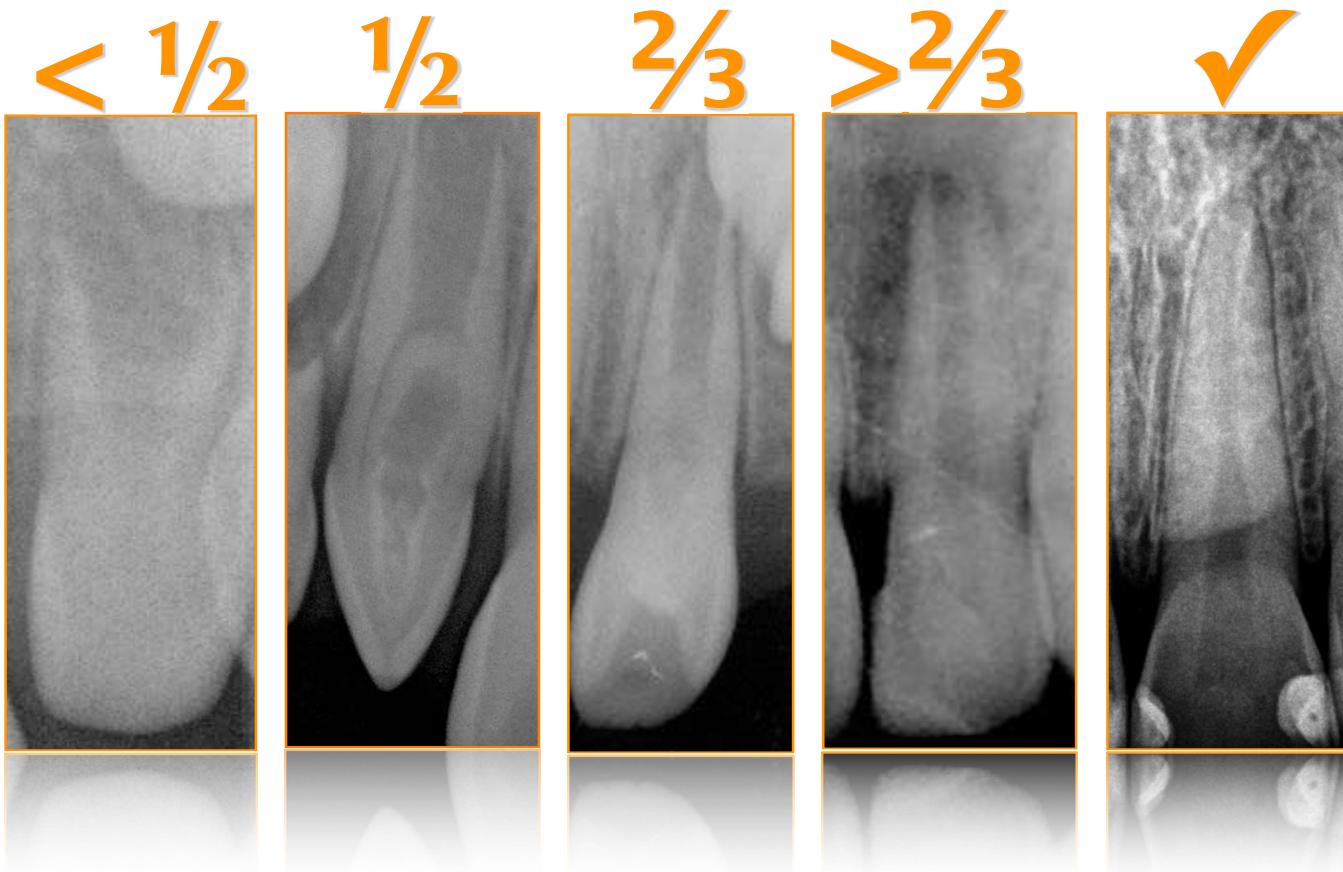
**OpalDam od. Fastdam**

# [Klassifikation]

(Cvek 1992)

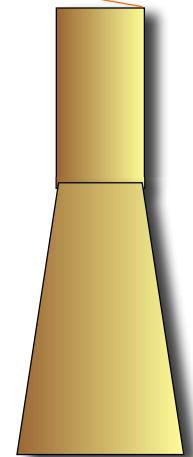
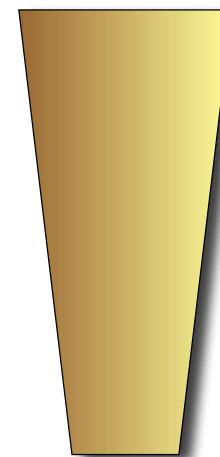
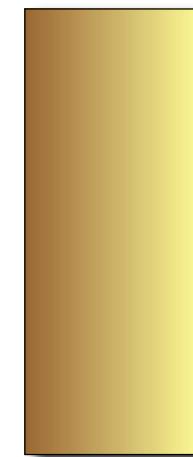
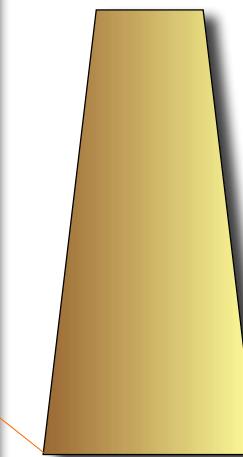
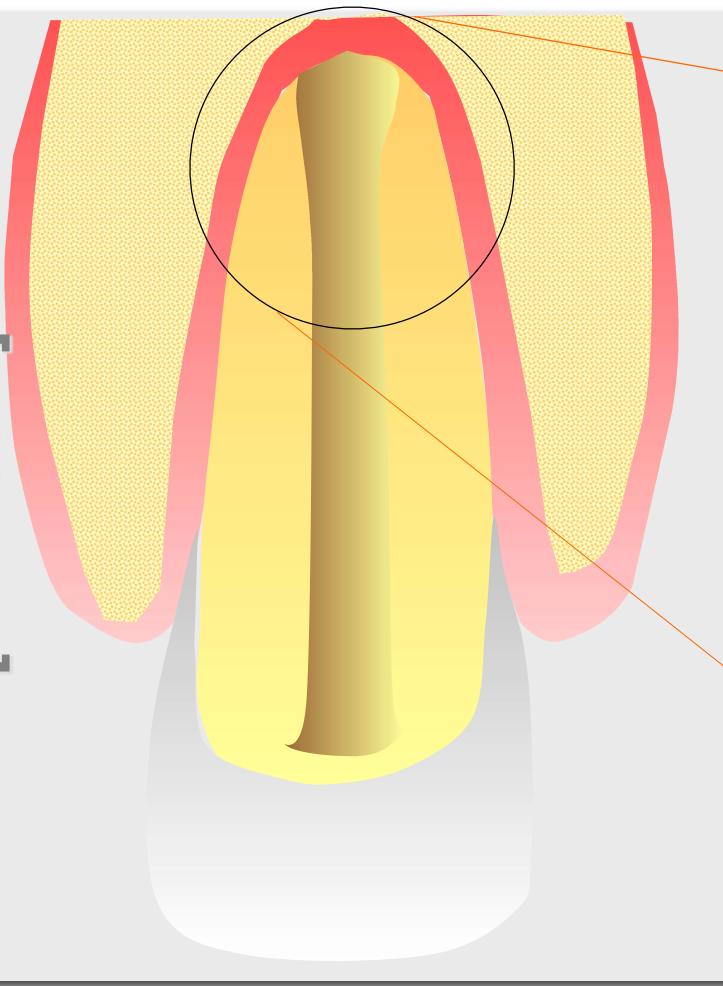


## Stand des Wurzelwachstums



# [Klassifikation]

[ klinisch ]



Irrigation

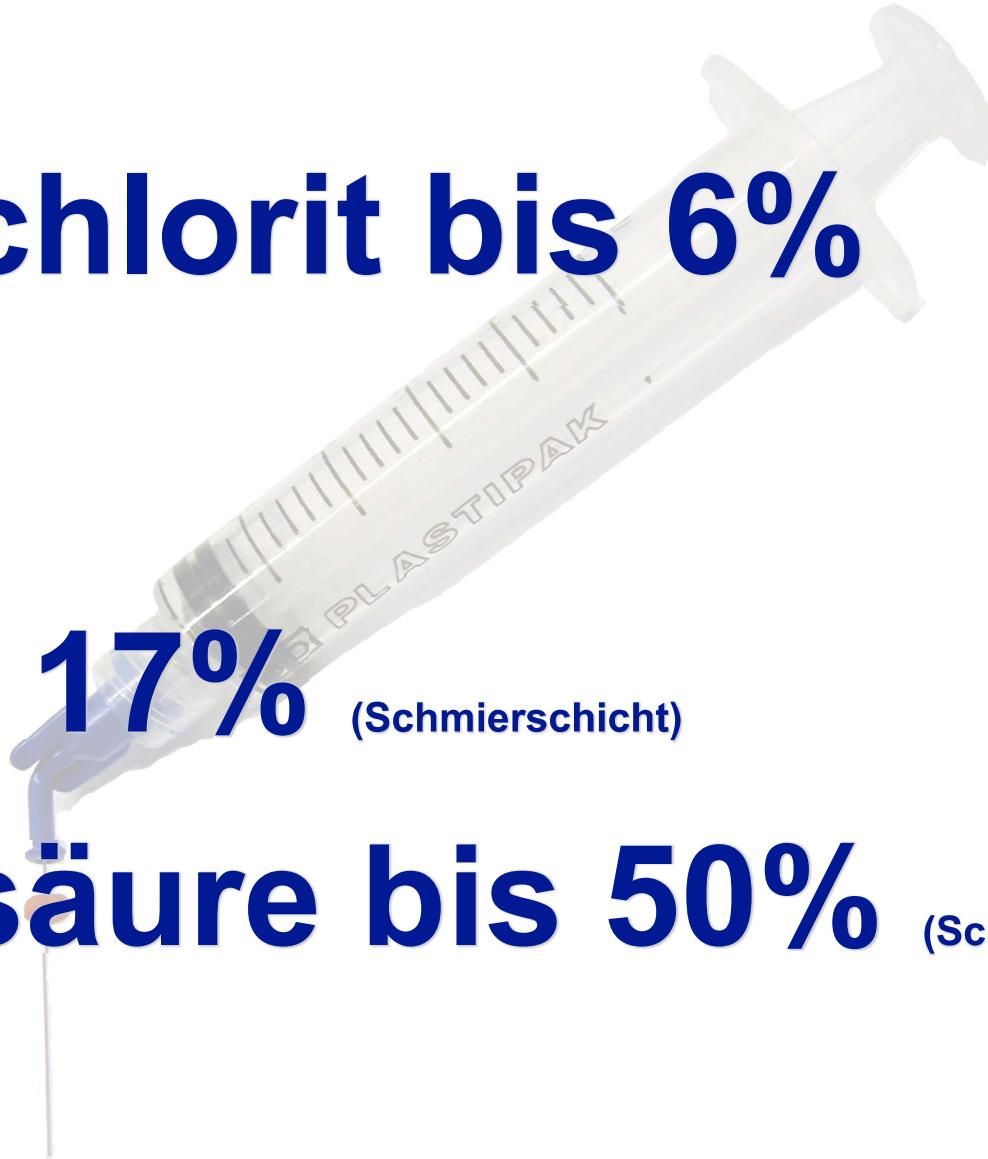
# [ Irrigation ]

**Na-Hypochlorit bis 6%**

**CHX 2%**

**EDTA bis 17%** (Schmierschicht)

**Zitronensäure bis 50%** (Schmierschicht)



# [Protokoll]

Zehnder JOE 2006

## Pulpitis      Nekrose & Revision

Desinfektion des Zahnes/Kofferdam **NaOCl**

Aufbereitung unter Spülung mit **NaOCl**

Nach Aufbereitung: Spülung mit **EDTA (1 min)**

Spülung mit **NaOCl (5 min)**

**Zwischenspülung**

Spülung mit **2% CHX (5 min)**

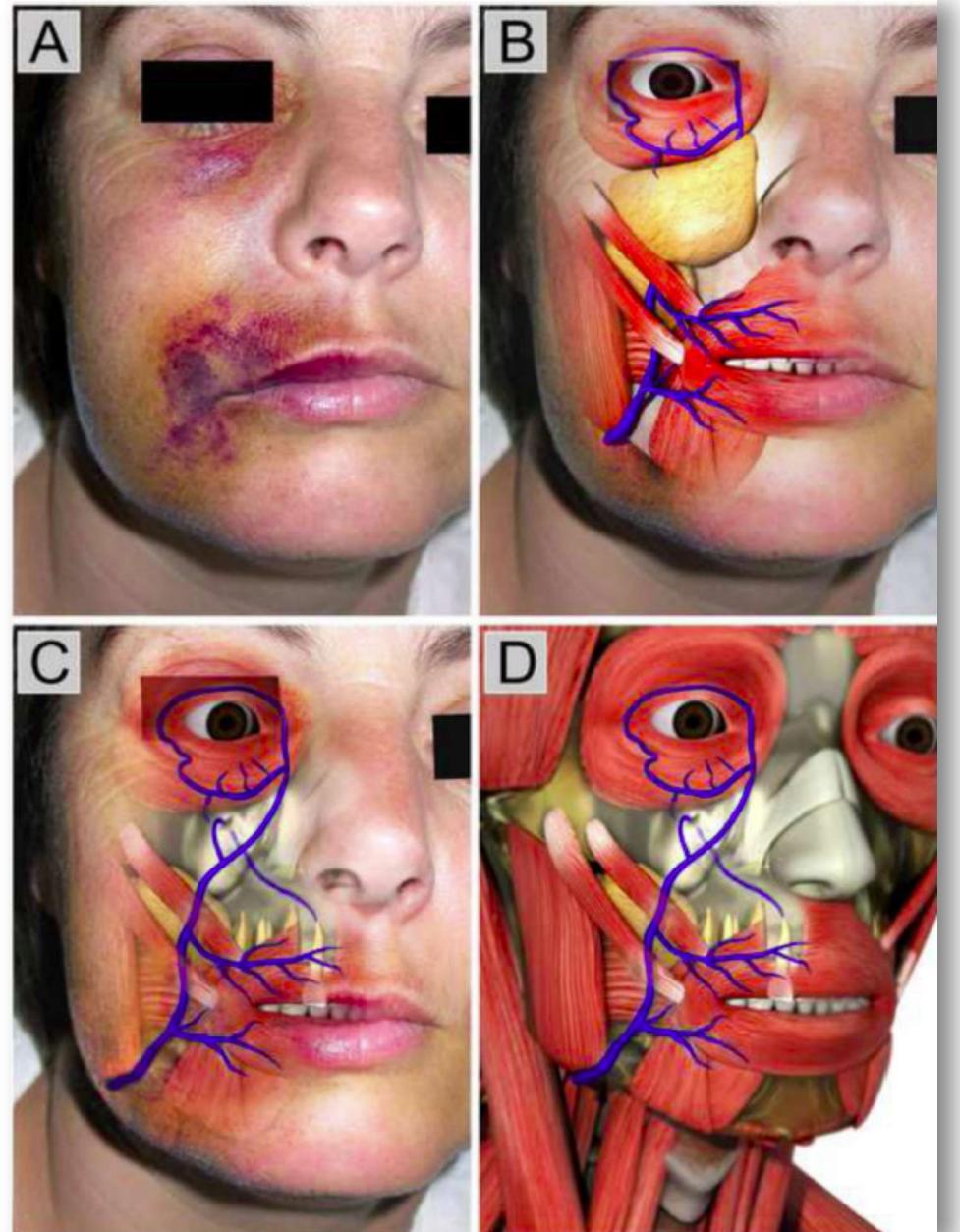
**Ca(OH)<sub>2</sub> Einlage (mind. 7d)**

Trocknung des Kanalsystems & Obturation

# [Spülunfall]

## Anatomy of Sodium Hypochlorite Accidents Involving Facial Ecchymosis – A Review

Wan-chun Zhu<sup>a,\*</sup>, Jacqueline Gyamfi<sup>b,\*</sup>, Li-na Niu<sup>c</sup>, G. John Schoeffel<sup>d,¶</sup>, Si-ying Liu<sup>e</sup>, Filippo Santarcangelo<sup>f</sup>, Sara Khan<sup>b</sup>, Kelvin C-Y. Tay<sup>g</sup>, David H. Pashley<sup>h</sup>, and Franklin R. Tay<sup>b,¶</sup>

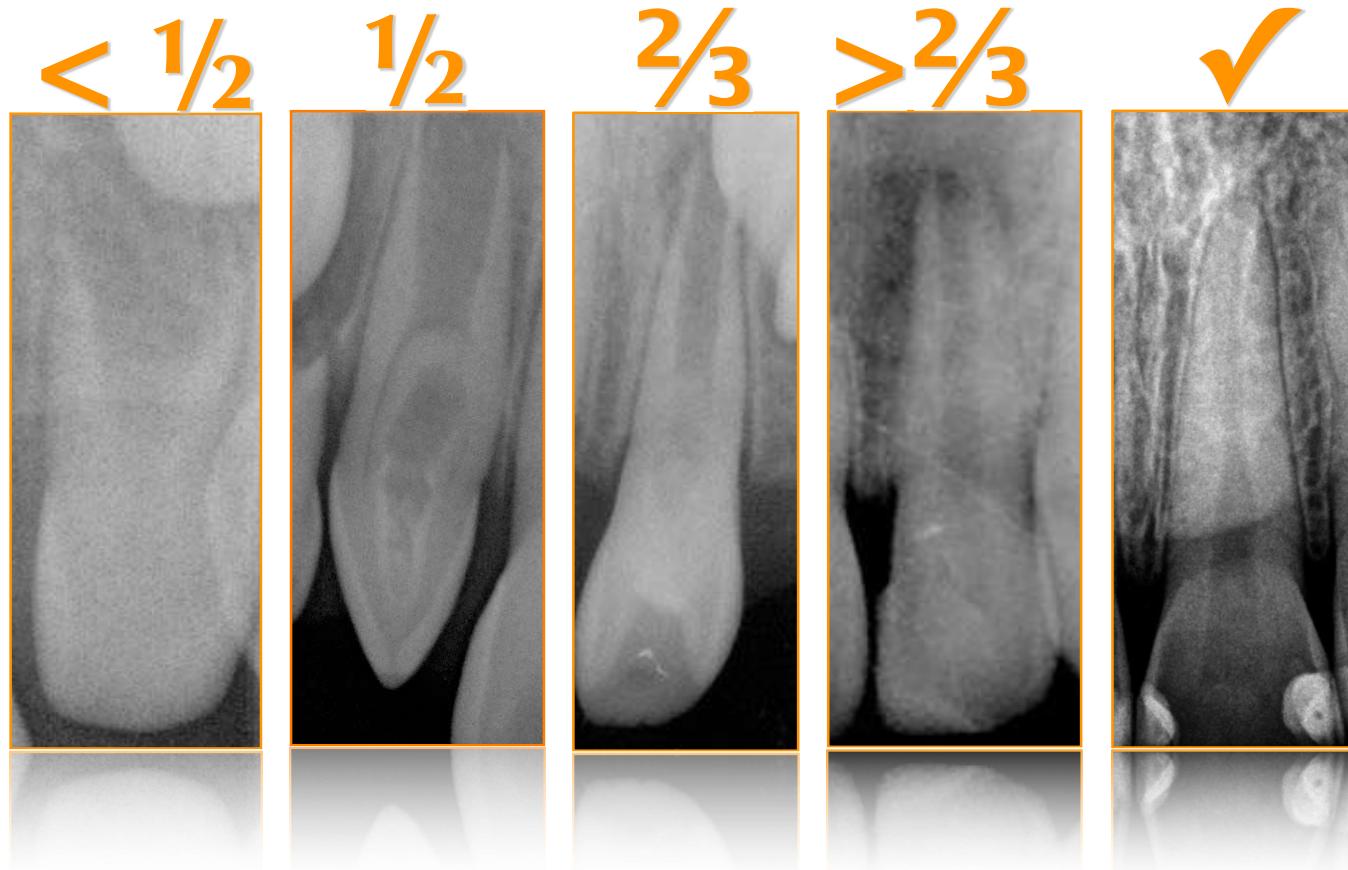


ObturAtion

# [Klassifikation]

(Cvek 1992)

## ● Stand des Wurzelwachstums



## ● Stand des Wurzelwachstums

### Apexifikation

- $\text{Ca(OH)}_2$
- MTA

### Regenerative Endodontie

## ● Stand des Wurzelwachstums

### Apexifikation

- $\text{Ca(OH)}_2$
- MTA

### Regenerative Endodontie

# [ Nachteile CA(OH)<sub>2</sub> ]

- Durchschnittliche Behandlungsdauer 5-20M

(Dominguez Reyes et al. 2005)



Ausgangssituation



6 Monate



14 Monate

Kühnisch & Heinrich-Weltzien

# [ Nachteile CA(OH)2 ]

- Durchschnittliche Behandlungsdauer 5-20M  
(Dominguez Reyes et al. 2005)
- Hohe Compliance notwendig
- Unregelmäßige Hartgewebsbarriere (Walia et al. 2000)
- Erhöhtes zervikales Frakturrisiko (Cvek 1992, Andreasen et al. 2002)

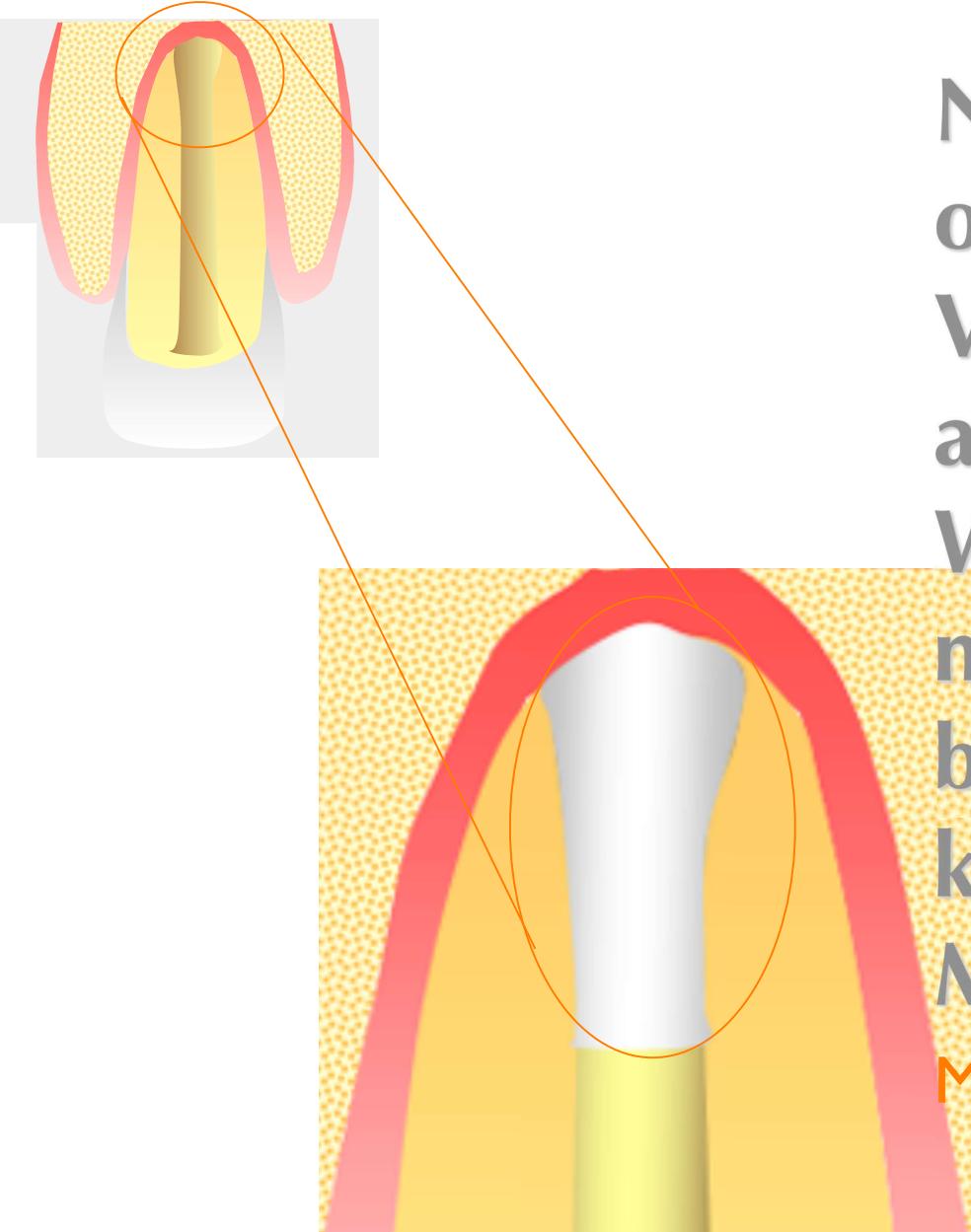
## ● Stand des Wurzelwachstums

### Apexifikation

- $\text{Ca(OH)}_2$
- MTA

### Regenerative Endodontie

# [Definition]

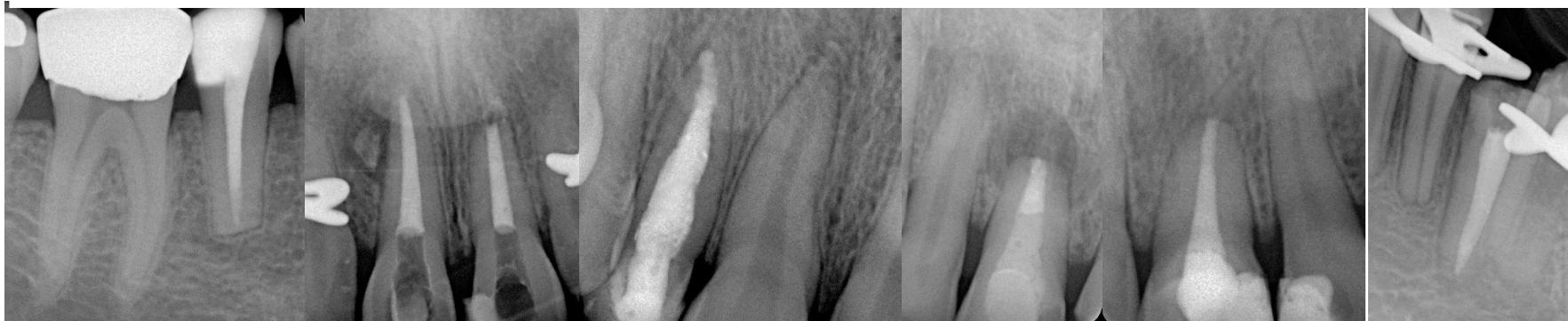


Nicht-chirurgischer  
orthograder  
Verschluss der  
apikalen  
Wurzelkanalregion  
mit einem  
biokompatiblen,  
kondensierbaren  
Material

Morse et al. 1990

# [ MTA-Apexifikation ]

- Verkürzte Behandlungszeit
- Geringeres Frakturrisiko
- Schneller Restaurierbarkeit
- Hohe Erfolgsraten



# [Klinisches Vorgehen]

● Foramen apicale  $\geq 0,6\text{mm}$

● 5mm Schichtstärke (Matt et al. 2004)

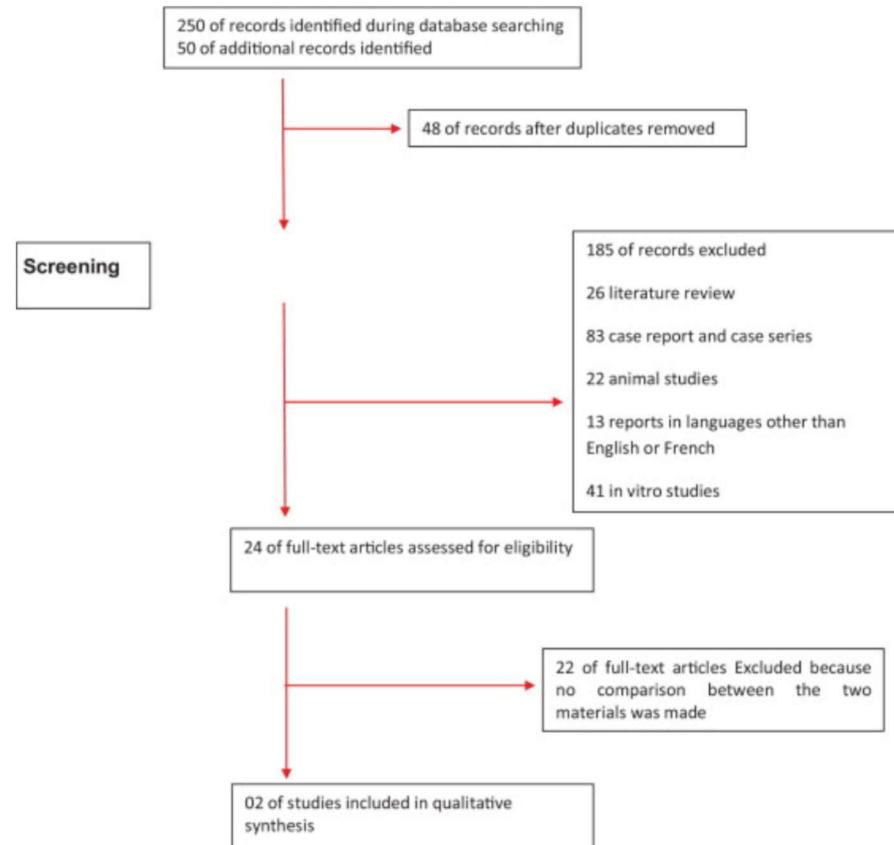
● Ind. Ultraschallaktivierung

(Yeung 06)



# Apexification of immature teeth with calcium hydroxide or mineral trioxide aggregate: systematic review and meta-analysis

Chala *et al.* 2011 OOOOE



Regarding success and apical barrier formation, either calcium hydroxide or mineral trioxide aggregate may be used for the apexification of immature teeth.

# Long-term outcome of MTA apexification in teeth with open apices

Katharina Bücher, DMD<sup>1</sup>/Franziska Meier, DMD<sup>2</sup>/Christian Diegritz, DMD<sup>1</sup>/Christoph Kaaden, DMD<sup>3</sup>/Reinhard Hickel, DMD, PhD<sup>4</sup>/Jan Kühnisch, DMD, PhD<sup>5</sup>

**Objective:** This retrospective study aimed to collect information about the long-term outcome of apexification treatment with mineral trioxide aggregate (MTA) of teeth with open apices. **Method and Materials:** A total of 98 teeth in 79 patients (m:f = 1:1.3) who had completed endodontic apexification treatment with MTA between September 2005 and January 2014 at a university dental clinic were considered. Both initial treatments and retreatments of former root canal treatments other than apexification were included. All patients were invited for a standardized follow-up visit. Data regarding age, sex, tooth type, reason for treatment, detailed treatment protocol, clinical and radiographic findings, treatment quality, and outcome were also collected from the patients' records. Descriptive statistical analysis was performed. **Results:** In the majority of cases, endodontic treatment was related to tra-

ma with fracture (45/98, 45.9%) and luxation injuries (20/98; 20.4%), followed by unknown causes (12/98; 12.2%), retreatments (7/98; 7.1%), hypophosphatasia (7/98; 7.1%), and caries (1/98; 1%). In the beginning, the Periapical Index (PAI) showed pathologic findings with a PAI > 2 in approximately 50% of cases, while 25% presented with minor or an absence of findings. At the end of the observation period, more than 90% showed clinical-radiographic success, whereas eight teeth were associated with an elevated PAI. Only 5% of cases needed further dental treatment, such as root-end surgery or retreatment of the root canal treatment. **Conclusion:** Within the limits of this retrospective investigation, clinical and clinical-radiographic success of the apexification treatment appears to make this a good and reliable treatment option for teeth with open apices. (doi: 10.3290/j.qi.a35702)

## ● Stand des Wurzelwachstums

### Apexifikation

- $\text{Ca(OH)}_2$
- MTA

### Regenerative Endodontie

## **Revascularization of Immature Permanent Teeth With Apical Periodontitis: New Treatment Protocol?**

Francisco Banchs, DDS, MS, and Martin Trope, DMD



- Erste Therapieansätze pulpaler Revaskularisierung nekrotischer, infizierter Zähne bereits ab 1971

(Nygaard-Ostby & Hjortdal (1971))

- Kollagen als artifizielles Material in Kanallumen

(Nevins et al. 1976/1977)

- Desinfektion des Kanals
- Applikation einer Matrix, um Einspülung zu ermöglichen
- Bakteriendichter Verschluss

(Windley et al. JOE 2005)

# European Society of Endodontology position statement: Revitalization procedures



**European Society of Endodontology developed by: K. M. Galler<sup>1</sup>, G. Krastl<sup>2</sup>, S. Simon<sup>3</sup>,  
G. Van Gorp<sup>4</sup>, N. Meschi<sup>4</sup>, B. Vahedi<sup>5</sup> & P. Lambrechts<sup>4</sup>**

<sup>1</sup>Department of Conservative Dentistry and Periodontology, University Hospital, Regensburg; <sup>2</sup>Department of Conservative Dentistry and Periodontology, University of Würzburg, Würzburg, Germany; <sup>3</sup>Department of Oral Biology and Endodontics, University of Paris Diderot (Paris 7), Paris, France; <sup>4</sup>Department of Oral Health Sciences, KU Leuven and Dentistry, University Hospitals Leuven, Leuven, Belgium; and <sup>5</sup>Private Practice, Augsburg, Germany

## Abstract

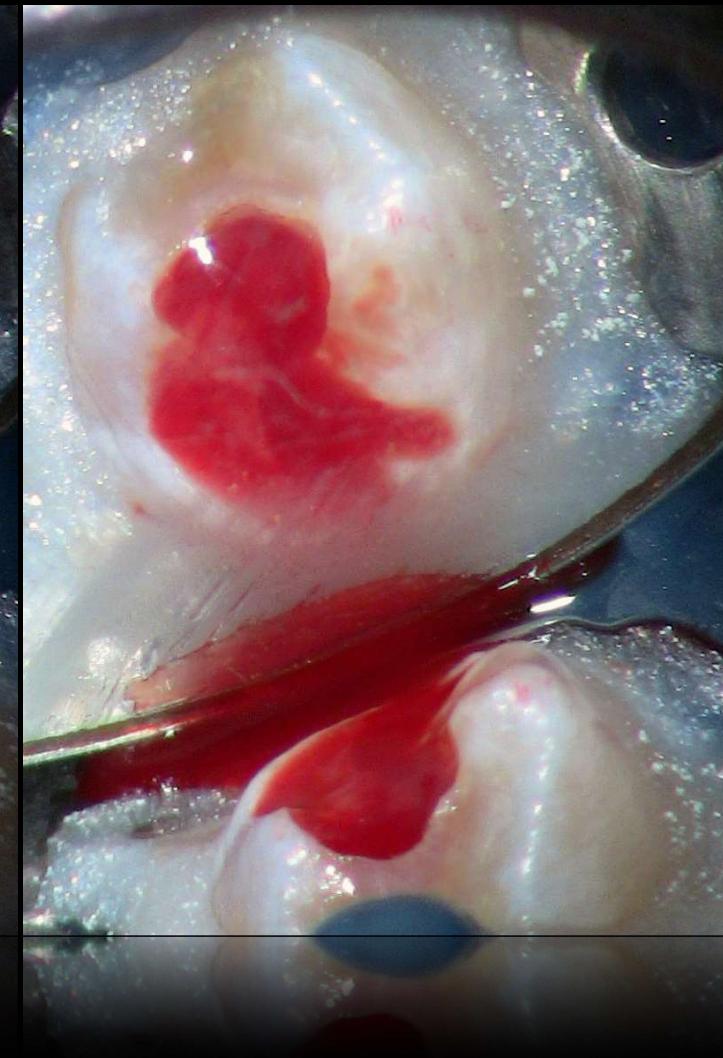
**European Society of Endodontology developed by:**  
**Galler KM, Krastl G, Simon S, Van Gorp G, Meschi N, Vahedi B, Lambrechts P.** European Society of Endodontology position statement: Revitalization procedures. *International Endodontic Journal*, **49**, 717–723, 2016.

This position statement represents a consensus of an expert committee convened by the European Society of Endodontology (ESE) on revitalization procedures. The statement is based on current clinical and scientific evidence as well as the expertise of the committee. The goal is to provide suitably trained dentists with a protocol including procedural details for the treatment of immature teeth with pulp necrosis as well as a patient consent

form. Revitalization is a biologically based treatment as an alternative to apexification in properly selected cases. Previously published review articles provide more detailed background information and the basis for this position statement (*Journal of Endodontics*, **39**, 2013, S30; *Journal of Endodontics*, **39**, 2013, 319; *Journal of Endodontics*, **40**, 2014, 1045; *Dental Traumatology*, **31**, 2015, 267; *International Endodontic Journal*, 2015, doi: 10.1111/iej.12606). As controlled clinical trials are lacking and new evidence is still emerging, this position statement will be updated at appropriate intervals. This might lead to changes to the protocol provided here.

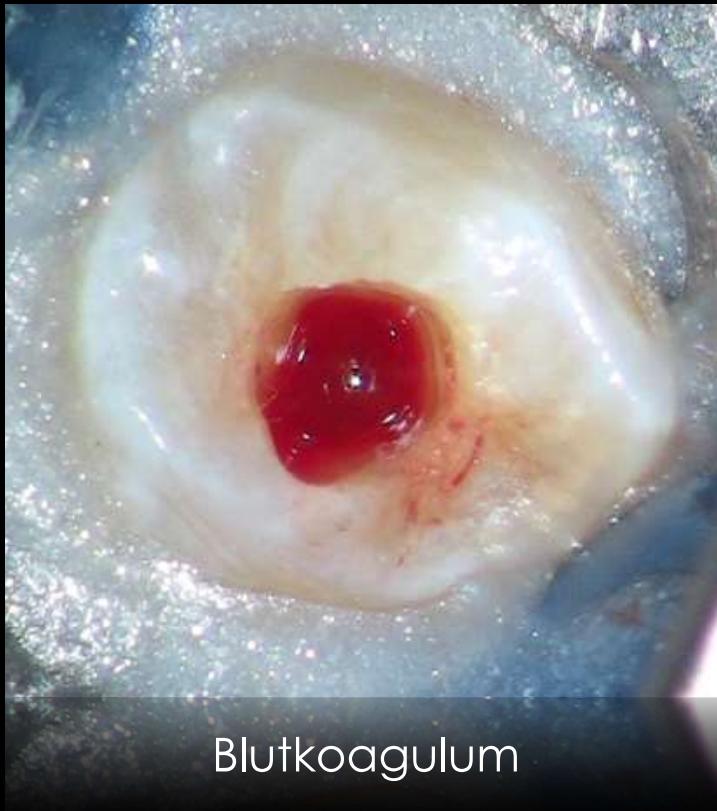
**Keywords:** Endodontontology, position statement, regeneration, revitalization.







apikale Blutung



Blutkoagulum



Kollagenmembran



MTA Applikation I



MTA Applikation II



MTA Applikation final



post op

RVG 6100



1 Jahr post op



01/2011



11/2013



01/2016



02/2020





**02/2013**



**01/2019**



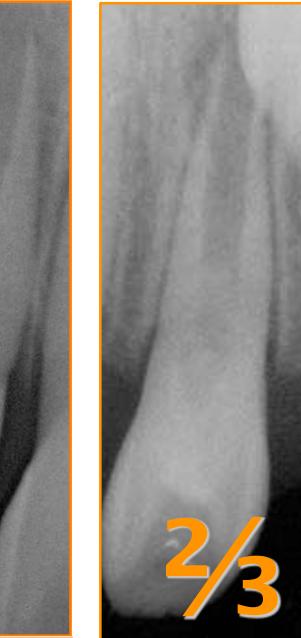
# [ Mögliche (zukünftige) Indikationen]

**Revit**  
...  
**Ca(OH)<sub>2</sub>**



$< \frac{1}{2}$

**Revit**  
**MTA**



$\frac{1}{2}$

**MTA**  
**Ca(OH)<sub>2</sub>**  
**Revit**



$\frac{2}{3}$

**Guttapercha  
& Sealer**



$> \frac{2}{3}$