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Dental Trauma Guide: A source of evidence-based treatment guidelines for dental trauma*

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Abstract – Diagnosis and treatment for traumatic dental injuries are very complex owing to the multiple trauma entities represented by six luxation types and nine fracture types affecting both the primary and the permanent dentition. When it is further considered that fracture and luxation injuries are often combined, the result is that more than 100 trauma scenarios exist, when the two dentitions are combined. Each of these trauma scenarios has a specific treatment demand and prospect for healing. With such a complexity in diagnosis and treatment, it is obvious that even experienced practitioners may have problems in selecting proper treatment for some of these trauma types. To remedy this situation, an Internet-based knowledge base consisting of 4000 dental trauma cases with long-term follow up is now available to the public and the professions on the Internet using the address http://www.DentalTraumaGuide.org. It is the aspiration that the use of this Guide may lead the practitioner to offer an evidence-based diagnosis and treatment.

Dental traumatology, the evidence problem

Dental trauma cases often result in a treatment sequence that involves both general dentists and many specialists. Optimal treatment relies upon the expertise of a broad spectrum of dental specialists such as oral and maxillofacial surgeons, paediatric dentists, endodontists, orthodontists, prosthodontists and periodontists. The primary urgent care is frequently provided by the oral and maxillofacial surgeon or the paediatric dentist in a hospital emergency department setting. Subsequently, the patient may be referred to a general dentist or an endodontist for secondary level care such as endodontic and restorative management. Later, the orthodontist and prosthodontists and periodontist may become involved with additional treatment. The long chain of referrals that are frequently seen in dental trauma cases means that control of the overall quality of treatment is often lost. While the specialists involved are usually eager to take credit for their successes, they are often very reluctant to take responsibility for the treatment failures. The research activity in clinical traumatology has been extremely low, and in some sense, dental traumatology has become an *orphan* in dentistry (1).

At the end of the last century, there was a growing interest among all dental disciplines in analyzing the validity of existing treatment principles that lead to the recognition that evidence-based dentistry with the randomized clinical trial (RCT) as the preferred level was the path for the future (2–4).In the famous pyramid 'Mount evidence', most studies in dental traumatology belong at very low levels in the evidence pyramid. Only a couple of clinical RCTs have yet been published, and the prospect for future RCTs appears slim (5).

What is the cause of this problem?

First of all, the shared responsibility among several dental specialities makes research in dental traumatology complicated to organize and evaluate. Secondly, the ethical problems associated with getting informed consent from an injured child or adult to participate in an RCT are unavoidable. Reasonable arguments for carrying out the

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experiments in spite of these problems are rarely present. This obstacle is almost prohibitive for most RCTs dealing with treatment for acute traumatic dental injuries.

What are the alternatives?

Often, animal models are the best alternative. They allow the researchers to control the parameters that may influence the outcome of the experiment in a fashion not attainable in human studies as the injuries can be inflicted by the examiner under controlled conditions (6). The current treatment guidelines give testimony to the value of animal studies as they rely heavily on information obtained from animal studies (7).

Are animal experiments reliable?

This question has been examined carefully and at least monkey experiments seem to have a high degree of reliability, whereas the use of dogs often seem to give too optimistic results in relation to pulp healing (6). Rat studies appear to show a significant variance in periodontal ligament (PDL) healing with a likelihood of transient ankylosis, which makes this model unreliable in dental trauma studies affecting the PDL (8).

Are human clinical non-randomised studies a valid approach to assessing the effect of dental trauma treatments?

If the correct statistical models are used and groups with similar preinjury and injury characteristics can be isolated and compared, then it is possible to reduce the amount of interference caused by confounding factors. The results must, however, be evaluated with a certain amount of reservation as the risk of interference by confounding factors can never be eliminated with certainty. This type of analysis has so far offered useful information about the effect of various treatment procedures such as repositioning, type and length of splinting times (9, 10) and the use of antibiotics (11).

How big is the knowledge gap before we can have the necessary scientific foundation for offering evidence-based treatment for all dental trauma types?

To answer that question, one must start by focusing on the strongest predictor for successful/unsuccessful trauma healing, namely the *trauma type*. Dental trauma can be divided into 9 fracture and 6 luxation entities. Combination injuries in which both luxation and fracture have occurred are unfortunately frequent, causing 54 combinations that must be seen as 54 distinct healing scenarios (12). The complexity is further increased by the fact that trauma to the primary and the permanent teeth must be treated as separate entities. This results in 108 distinct trauma scenarios! One single word may characterize treatment for traumatic dental injuries around the world: CHAOS.

Several predictors for pulp and periodontal healing have been identified for the individual trauma entities. Some reflect the *severity and nature* of the trauma inflicted, some describe *patient characteristics* and some reflect the influence of the *choice of treatment*.

The *stage of root development* appears to be a strong outcomes predictor for all types of dental trauma, and it affects both pulpal and periodontal healing. This is not surprising because a good blood supply is essential for pulpal healing and thus the size of the apical foramen is directly related to the revascularization potential of the affected tooth (13, 14).

The choice of treatment offered has a direct effect on the healing outcome for *luxation injuries* where several treatment options frequently are available such as ± repositioning, ± splinting and ± antibiotics (14). For treatment of *crown fractures* with exposed dentin and/or the pulp, the amount of research needed before reliable answers to all treatment possibilities has been covered seems formidable (15). For *crown-root fractures,* there are several treatment options, but extensive research is needed before reliable answers can be established as to which treatment option offers the best possible treatment (16).

The multitude of possible trauma scenarios and the broad variety of treatment options make it very difficult for practitioners to provide evidence-based treatment and recommend the best possible treatment choice for the patient. Keeping this in mind, it is not surprising that much dental trauma treatment worldwide is far from ideal. Surveys in England, Australia, New Zealand, Tanzania, Brazil, Switzerland have shown that knowledge of adequate treatment for traumatized teeth is deficient, implying that up to half of all treatments offered are either not necessary or directly harmful to the patient (17–31).

The *Dental Trauma Guide* is an attempt to elevate this unfortunate situation by making the current knowledge in dental traumatology easily available on the Internet. For 40 years, patient records have been collected at the University Hospital in Copenhagen, creating the information contained in the extensive database used in developing the *Dental Trauma Guide* for prognosis estimation. Since 1965, standardized documentation of trauma treatments has been collected, and this large material (4000 cases) together with the results of 79 clinical studies and 65 experimental animal studies using monkeys now forms the scientific basis for the *Dental Trauma Guide* (7) (Fig. 1).

An effort has been made to make the information available in a structured and userfriendly fashion allowing the practitioner to develop a correct diagnosis, a treatment plan and a follow-up plan along with identifying a risk estimate for healing complications.

Arriving at the correct diagnosis

As previously mentioned, a traumatized tooth may suffer one of 108 distinct trauma conditions. The correct choice of treatment is obviously dependent on the ability of the practitioner to make the correct diagnosis. In this respect, the Dental Trauma Guide will follow the international WHO classification (32). To help the newcomers in dental traumatology, a *Trauma Pathfinder*

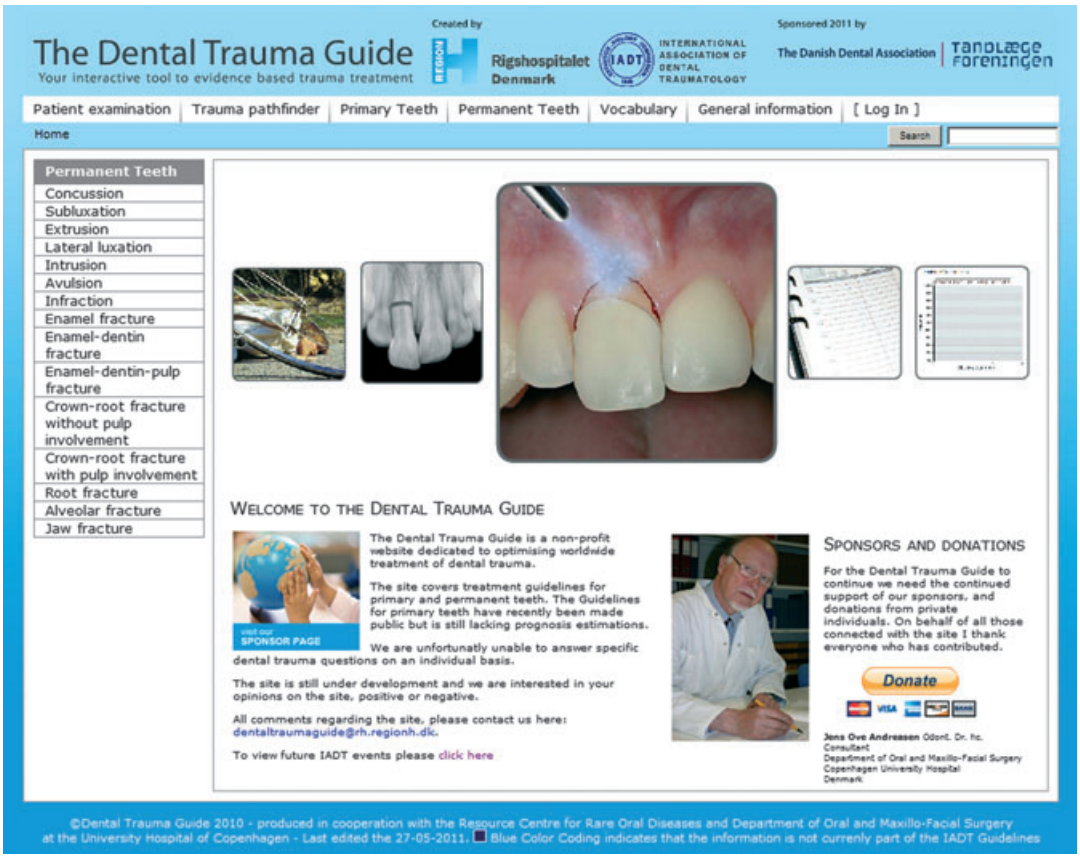

Fig. 1. Homepage of the Dental Trauma Guide.

will be incorporated in the website to guide the practitioner via a series of 'yes' and 'no' questions to a correct diagnosis (Fig. 2).

At a later stage (Version 2.0), an interactive *Electronic Patient Record* will be included in the guide. It will be possible to use The Electronic Patient Record as a quality measure as this record will remind the practitioner to perform and answer all pertinent questions and test for the trauma entity being recorded.

Selecting treatments which may optimize pulp and periodontal healing

A paradox in dental traumatology is that almost all treatment procedures impose an element of new trauma when applied, i.e. being *traumatogenic* (5, 33). To mention a few, repositioning of a displaced tooth manually or by forceps will damage or destroy thousands or millions of PDL cells. Application of many types of splints, especially arch bars, in which loosened teeth are fastened to an arch bar with wires will create large compression zones in the PDL attributing to tightening of the steel wires and establish invasion paths for bacteria along subgingivally placed wires. Insufficient coverage of exposed dentin and pulp may lead to microleakage with formation of anaerobic bacterial colonies that may seriously damage the pulp. Proper treatment selection which sometimes means minimal or no treatment is therefore crucial.

In the *Dental Trauma Guide,* treatment approaches are presented for which treatment effects have been documented experimentally in animal models and at least to some extent in clinical studies. In case of treatment alternatives, the pros and cons for each treatment is outlined.

Follow-up regimens for dental trauma patients

An optimal follow-up plan should aim at selecting points in time where the chances of diagnosing healing complications are most effective. For obvious reasons, cost and the convenience of the patient and practitioner have to be taken in to consideration when constructing a good and cost-effective control system. The suggested follow-up plan for a given trauma entity is proposed based on a series of clinical studies where survival analysis has documented the most optimal time for diagnosis of pulp and periodontal healing complications (34).

Description and diagnosis of healing complications

In the *Dental Trauma Guide,* the terminology of healing complications has been based on the 2007 edition of the *Textbook and Color Atlas of Traumatic Dental Injuries* by Andreasen et al. (33).

In relation to pulpal healing the following outcome descriptions are used:

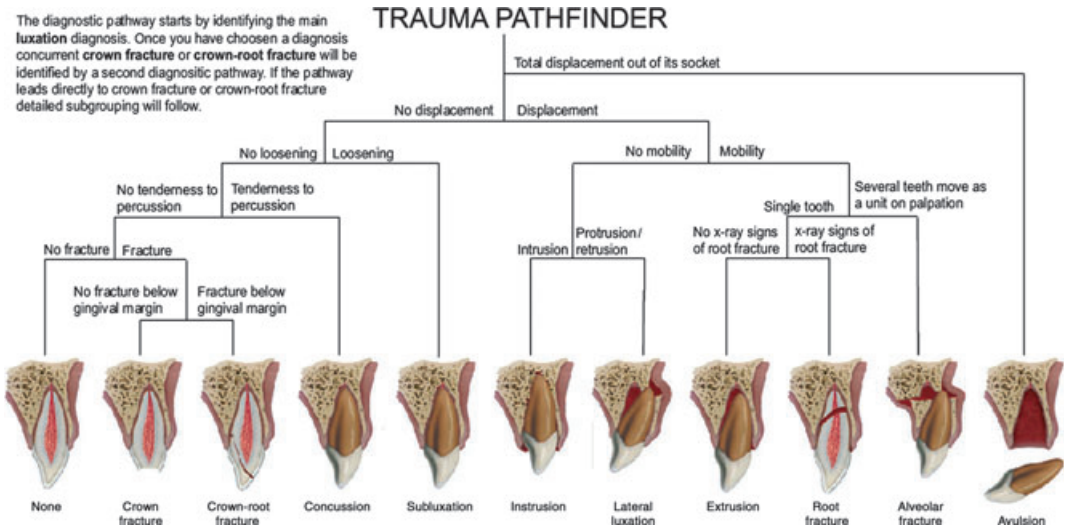

Fig. 2. Dental Trauma Guide showing trauma pathfinder.

1 *Pulp necrosis* (sterile or infected).
2 *Pulp canal obliteration* (partial or total).
3 *Pulp metaplasia* including internal PDL and/or bone formation.

In relation to PDL healing, the following healing complications are described:
1 Repair-related root surface resorption.
2 Infection-related root surface (inflammatory) resorption.
3 Progressive or transient osseous root surface ankylosis-related (replacement) resorption.

Root resorption may also occur in the root canal whereby the following entities appear:
1 Repair-related root canal resorption.
2 Infection-related root canal resorption.
3 Osseous ankylosis-related (replacement) root canal resorption.

Concerning the marginal periodontium, the following two entities are recognized:
1 Permanent marginal bone loss
2 Transient marginal bone loss.

In regard to root development disturbances, traumas often affects teeth with incomplete root formation at time of injury and the healing complications are often *partial* and *total arrest* of further root development.

Finally and probably the most essential complication is *tooth loss* usually caused by the above-mentioned healing complications.

Prediction of healing complications

This topic will be described in a subsequent article describing the construction of a calculator providing individualized prognoses for traumatized teeth based on a

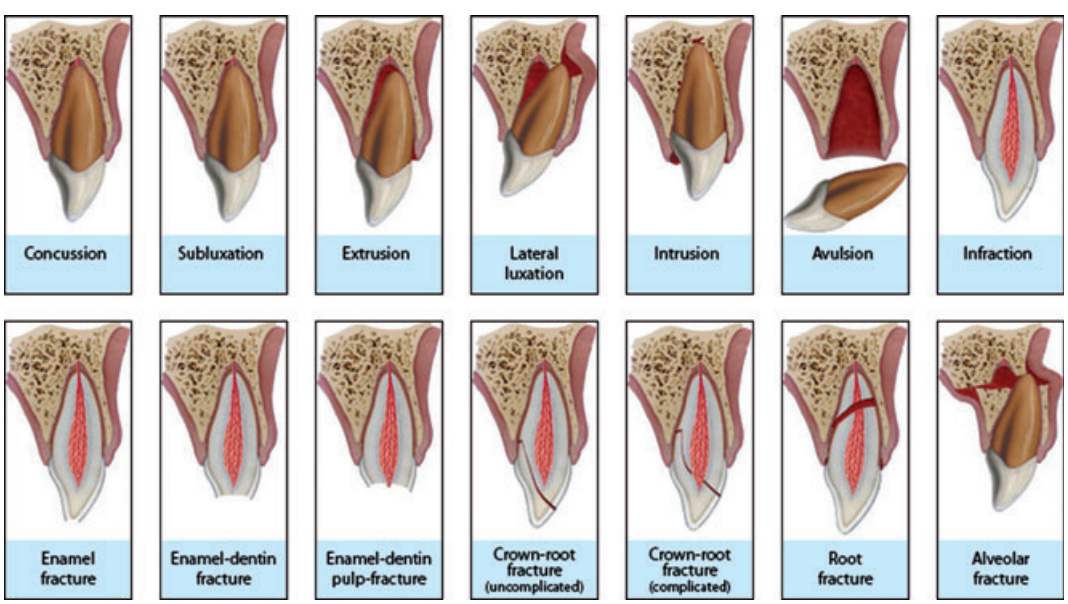

Fig. 3. Trauma entities affecting the permanent dentition.

matching with cases from the above mentioned hospital database on long-term follow up on dental traumas.

What is the status of Dental Trauma Guide?

In 2005, it was decided to combine all the existing trauma databases covering various dental trauma entities at the University Hospital in Copenhagen to one unit. This implied harmonizing 18 individual trauma studies, a project that included and extensive amount of work. In 2008, the data from these 18 studies had been harmonized and were ready for an overall predictor analysis; this project is about to be completed now.

The first version of the Dental Trauma Guide (Version 1.0) includes all injuries affecting the *permanent dentition* and is now available on the Internet (Fig. 3). The next step in the development of the Dental Trauma Guide will be to incorporate information about *primary tooth injuries* and their subsequent sequelae to permanent successors; this work on the primary tooth injuries is now completed (Fig. 4), but the prognosis part will be released later 2011 (Version 2.0).

Economic background behind the Dental Trauma Guide

The project has only been possible thanks to a number of national and international sponsors. In this regard, the Copenhagen University Hospital, the Copenhagen Dental School, the Danish National Dental Association, The Public employed and various research funds (The Regional State Dental Research Foundation, Velux Foundation, Augustinus Foundation, and Spies Research Foundation) have been instrumental in the initial phase of the project. International, important supporters, such as the American Association of Endodontists (AAE), the International Association of Dental Traumatology (IADT), the European Association of Paediatric Dentistry (EAPD), the Swedish and Danish Paediatric Society and the Greek Orthodontic Society have all made significant contributions to fund the construction of Version 1.0.

In the future, there will be a continued need for grant support in order to keep the *Dental Trauma Guide* 'alive'. Negotiations with possible sponsor organisations are under way. It is the hope that sponsorships will be able to keep *the Dental Trauma Guide* alive and growing in the years to come.

Staff behind the Dental Trauma Guide

The principal investigator is Dr. Jens Ove Andreasen and the chief programmer and developer is Søren Steno Ahrensburg. These two are supported by a series of other investigators such of Dr. Eva Lauridsen and Dr. Nuno Hermann, both attached to the Department of Pediatric Dentistry and Clinical Genetics, Copenhagen Dental School. Furthermore, the following staff oral and maxillofacial surgeons, Dr. Søren Hillerup, Dr. Thomas Kofod, Dr. Ole Schwartz, Dr. Simon Storgaard Jensen and research associate Dr. Frances Meriam Andreasen are participating. The following statisticians from the BioStatistical Department of Copenhagen University have been advisors or are currently working on statistical modelling for the statistical part of the *Dental Trauma Guide*, Thomas Gerds and Per Kragh Andersen.

Aims for the future of the Dental Trauma Guide

It is the aspiration of the designers of the *Dental Trauma Guide* that it may raise the standard of care of dental trauma patients worldwide. The dental trauma problem is certainly a global phenomenon. The frequency of dental traumas in a population is very high and involvement is estimated to be a round 50–60% (including both the primary and the permanent dentition) (32). It is likely that the world today has more than 3 billion

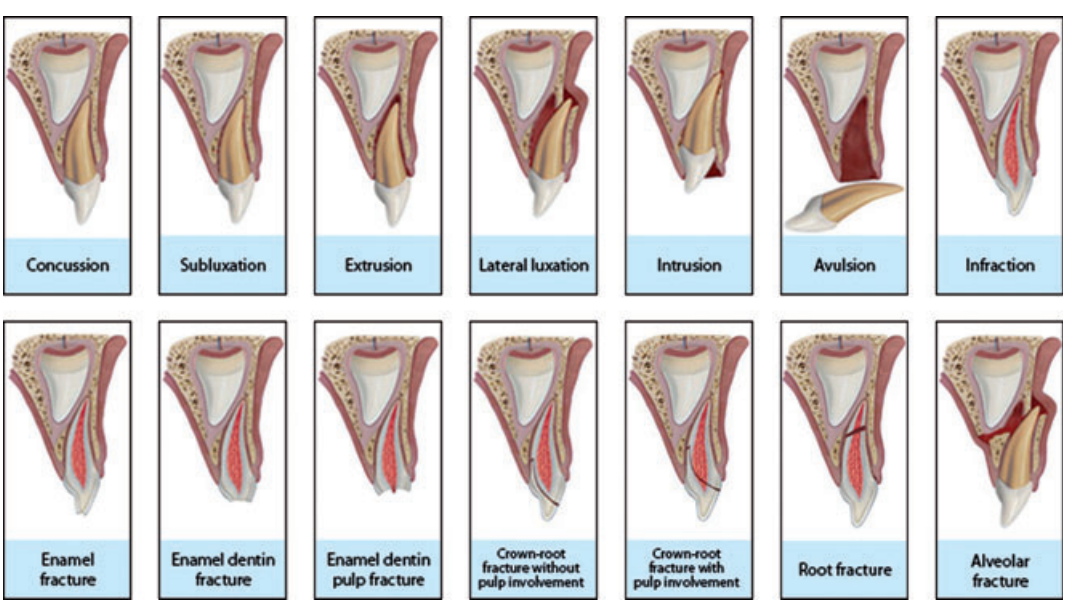

Fig. 4. Trauma entities affecting the primary dentition.

trauma victims and to this figure is added 60 million new patients each year!

In 1989, a study was conducted in Denmark and Sweden where the cost of the first 'definitive' treatment for dental traumas in children was calculated and it amounted to US$8 000 000/per million inhabitants, a figure which has doubled since then (35, 36). It is very important to note that this figure does not include all the costs of the definitive treatment(s) at adult age. This is certainly imposing a serious financial burden on all trauma patients and to some extent also on the society. If the guide can optimize the initial treatment, which is so crucial for the final outcome, this may lessen the multiplicity of problems facing all trauma victims.

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