The vital amputation (VA) of deciduous teeth with the goal of maintaining their function for a limited period is a contro-versial subject. However, is only ap-proved for therapeutic agents such as calcium hydroxide (Ca(OH)2) and mineral trioxide aggregate (MTA) are recom-mended by the European Society of Endodontontology (ESE) defines pulp amputation as a procedure dur-ing which part of the exposed vital pulp tissue is removed with the aim of maintaining vitality and function of the remaining parts of the pulp. The authors suggest several reasons for this failure: pulp already heavily inflamed initially; too much pressure applied during application; and disposal of the blood coagulum via haemostatic agents.

Seidler states the following regarding the success of VA:2

- A higher rate of success is observed in cases of intragincal pulp exposure.
- Treatment success is reduced in cases of complete root growth.
- Molars are more successful than incisors.
- For a pulpotomy with Ca(OH)2, Jensen presupposes that Ca(OH)2 pulpotomies can be successful only if teeth are fully treated than incisors.
- The European Society of Endodontontology (ESE) defines pulp amputation as a procedure during which part of the exposed vital pulp tissue is removed with the aim of maintaining vitality and function of the remaining parts of the pulp.1 ESE recognises the following indications for VAs (i.e. pulpotomy):
- 1. treatment of deciduous teeth;
- 2. treatment of permantens with incompleat root growth; and
- 3. emergency measure.

McDougal et al. report on 75 erupted pulpotomies on aching permanent molars and premol-ars.4 A clinical success rate of 90% after six months and 78% after 12 months was ob-served. The teeth, which were rendered painless per se without analgesics, diagnostically controlled and it was shown that 40% of the teeth were free of pathological findings after six months and 42% after 12 months.

According to Jensen, pulpotomy is an attempt to stimulate hard tissue healing at the area of ampu-tation.5 Fountain and Camp point out that a pulpotomy may result in canal calcification, internal resorption or necrosis of the pulp.6 Kozlow and Masler refer to literature that reports the formation of a dentine bridge in rat teeth under non-calcium-containing materials, such as wax, amalgam, acrylic resin and zinc oxide eugenol.9 In human teeth, the bridging under Ca(OH)2 was successful in 45% of the cases and histopathological investigations in 23% of the cases. During their own tests on rat teeth, the authors assessed good reparative reac-tions with complete bridging fol-lowing pulpotomy with Ca(OH)2, zinc oxide-eugenol, cortisone and silver amal-gam.

According to Alacam, various materials are recommended for pulpotomy: Ca(OH)2, formocresol, glutaraldehyde, ferrous sul-phate, zinc oxide eugenol and polyacrylate cement.10 Salako et al. compared MTA, formocresol, ferrous sulphate and bis-active glass with regard to their pulpotomy compati bility and found MTA to be the ideal pulpotomy agent.11 Agents that contain CH2O-containing agents on human teeth. However, he observed that for several weeks fol-lowing pulpotomy there was a possibility of a hard substance barrier form- ing.18

Chandani et al. et al. performed partial pulpotomies using Ca(OH)2 on 37 permanent teeth (55 molars, 2 premolars).15 The patients were six to 15 years old and the pulpotomy had to be performed at least two years prior to inclusion in the study. Check-ups were performed at an average of 56 months (24 to 140). The teeth were separated into two groups (Table 1). The fail-ures occurred in the first group, in teeth with incom-plete root growth (after ten days and 48 months). The other 29 teeth (93.5%) were treated successfully. In the second group, two failures occurred (after 10 and 24 months) in teeth with periodontal gap enlarge-ment (one tooth with complete root growth and the other with incomplete root growth). Molven states that there were no pathological findings in 1,351 root filled roots in 51.6% of the cases and in 256 pulpotomized roots in 65% of the cases.14 As-gary and Eghlal report the success ful use of a new VA agent called CEM, a cement mixture enriched with Ca, in 205 pulpotomies on molars.15

For comparison, 202 molars were extripated vitality. The root canal filling (RCF) was per-formed via lateral condensation with AH Plus (DENTSPLY De- Trey) as sealant. After seven days, 58% of the pulpotomy treated and 60% of the root canal-treated patients recovered needing analgesics. After six months, 89.94% of the patients underwent a radiological check-up. The pulpotomy patients re-vealed a significantly higher suc-cess rate (p < 0.001).

The most frequently used VA agent for deciduous teeth is formocresol, a mix of CH2O, cre-sol, glycerine and water. A survey showed that formocresol pulpotomies on deciduous teeth were performed by general den-tists in 75% of the cases and by paediatric den-tists in 98.2% of the cases.16 The frequency of use on permanent teeth was lower: 18.9% for general and 55.4% for paediatric dentists. Fischer published the results of pulp amputations of 600 teeth, which were performed with the CH2O-conta-ining preparation Triacine.17 Check-ups were done between six months and 18 years after amputation. Exam-i nation of the X-ray controls re-vealed a pathological apex in 9%. Eleven teeth were histologi-cally examined. Hard substance formation was observed in the form of apical foramen closures and apposition at the lateral canal walls, which partially led to obliteration of the canal lumen.

During an accelerated test lasting up to 2.5 months, Overdike tested N2 as CH2O-containing VA agent on human teeth. He observed that for several weeks fol-lowing N2 application there was a possibility of a hard substance barrier form- ing.18

Over a period of 12 years, Stern carried out 175 N2 pulpotomies under relative isolation on teeth with complete root growth, regardless of possible anamnetic amass. Fifteen per cent of the patients experienced increased pain after treatment, which subsided within 48 hours. Four patients, however, developed pulpsitis, which resulted in the extraction of three teeth and conservative RCT of one tooth. Stern was aware to track the outcome of 55 vitaly amputated teeth over a longer period. During the course of check-ups, two teeth were extirpated, one of them due to a fracture. Five years after treatment, Stern observed advancing calcification of the nerve channels.

Frankl considers the advantage of pulpotomy compared with RCT as there being no instrument fractures or perforations during pulpotomy. A possi-bile failure could always be countered with a RCT. He asserts that Ca(OH)2 pulpotomies can be successful only if teeth are asymptomatic prior to treatment and for accidentally opened pulp and, therefore, bleeding from the pulp.
Material and method

The study was conducted in my dental practice, which is located in a rural area. Between 1994 and 1998, 1,795 VA s and 1,945 VEs were performed on permanent molar patients. The VA patients ranged between 22 and 55 years. Failures manifested by pain within 48 hours amounted to 2%. The aim of the following study was to analyse the success and failure rates of VA s and VEs.

During the treatment period, only those patients with toothache at the district hospital of Düsseldorf, Germany, on 8 February 1996, was used as therapeutic agent (see Table II for composition).

The root canals were prepared according to the RCF method: relative isolation, no root-canal rinsing and root-canal obturation with resins only,21. For the RCF, N2 mixed to less, the total failure rate for vital molars was 19%. However, the extraction rates were reported low (28.3%) for VA s and 49.4% for VEs. The total failure rate (radiological and clinical criteria) was calculated for VA s and VEs, which is equivalent to that of VEs with slight underfilling (RCF level 4, 5). Adequately filled root canals led to fewer failures (8.9%) than VA s. With a failure rate of 1.9%, the lower first VEs and second VAs were most frequently affected.

The patients should be advised—besides a full pulpotomy, which was the subject of this study—a partial pulpotomy on:

- upper molars: VA of the buccal canal; filling of the palatal root; and
- lower molars: VA of the mesial canal; filling of the distal root; and
- deep crown margin caries, partial removal of the pulp cavum.

The correlation between failure and RCF level following VA s was investigated. Adequately filled teeth (-2, -1 adipecum) showed a failure rate of 1.2%, whereas inadequately filled teeth averaged a failure rate of 22.1%. Hence, the conclusion may be drawn that the introduction of pulpotomy corresponds to the one of properly performed root fillings following VEs, and is far superior to a notice-

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