

# ENDODONTIC TREATMENT OF YOUNG PERMANENT TEETH



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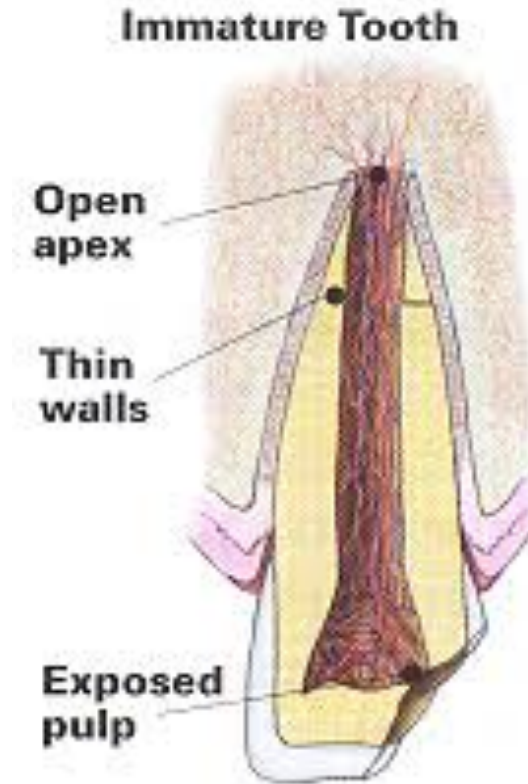
Permanent young tooth (immature):

- ✓ Incompletely formed root;
- ✓ Open apex.

The absence of anatomical structures in the terminal area of the root (structures that are replaced by a formative organ) forces us to apply **special endodontic techniques**, different from those applied to mature permanent teeth, in case of pulpal or pulpo-periodontal damage of these teeth.



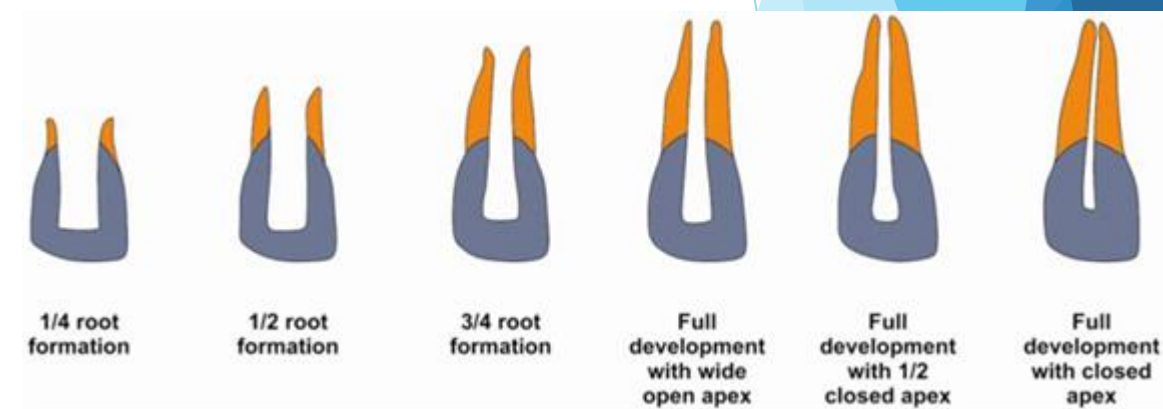
maintaining pulpal vitality at least partially (root pulp or apical pulp) to allow further root formation and apex maturation.



Crown formation → Eruption → Complete root formation →  
 3 years → | → + 3 years

- The root begins to form only after the crown has reached its final size.
- The signal for the beginning of the formative activity is given at the area level in which the transition is made from the external adamantine epithelium to the internal adamantine epithelium.
- This epithelium continues a circular proliferation in the underlying connective tissues, forming for each root a thin epithelial sleeve (Hertwig's epithelial sheath).

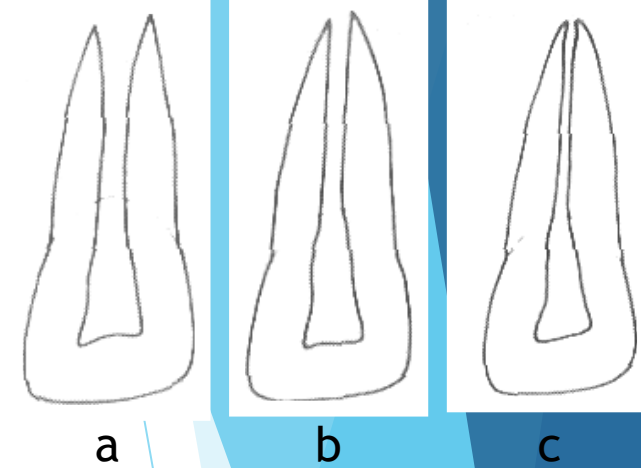
Tooth	Complete crown formation	Eruption	Complete root formation
1	4 years and 6 months	7 years	9 years and 6 months
2	4 years and 6 months	8 years	10 years and 6 months
3	6 years and 6 months	10-11 years	13-14 years
4	5 years and 6 months	9 years	12 years
5	6 years and 6 months	10-11 years	13-14 years
6	3 years	6 years	9 years
7	7 years and 6 months	12 years	15 years
8	15 years	18 years	20 years



- The development of the immature apical area involves the passage of this segment through 3 successive stages, in which the boundary walls are at first divergent, then parallel and finally convergent, a stage in which the characteristic narrowing of the mature tooth is achieved.

Stages of apical area development:

- (a) Divergent walls
- (b) Parallel walls
- (c) Convergent walls.



- Normally, the maturation of the permanent tooth is done by an apical constriction of the canal leading to the formation of the apical foramen. It is usually located 0.5-1 mm from the anatomical apex and has a diameter of 0.3-0.6 mm.
- Conversely, a root with an open apex does not have this constriction and the apical opening is very wide.
  - The "typical" open apex occurs when a pulpal necrosis affects a permanently immature tooth, before the complete growth and development of the root. Odontoblasts degenerate, dentin deposition is interrupted and in addition, through periapical complications, the epithelial diaphragm is destroyed - root-forming → odontogenesis ceases → the root is shorter and the apex is incompletely formed.
  - The "occasional" open apex is the result of extensive resorption of a mature apex as a result of orthodontic treatment, periapical pathology, or trauma.

*The etiological factors incriminated in the etiopathogenesis of pulpopathies of young permanent teeth* are similar to those involved in mature teeth, but the anatomical features of immature teeth (voluminous pulp chamber, relatively thin layer of dentin and increased permeability) make them more vulnerable to aggressive factors.

**permanent young tooth** → increased biological capacity (due to numerous cellular elements and rich vascularity).

↓ ↓ ↓ ↓ ↓

factors favorable to the reversibility of inflammatory phenomena and healing.

The 3 main causes that generate pulpal changes are:

- untreated dental caries;
- therapeutic maneuvers;
- trauma.

**changes** that may occur in pulpal structures = inflammatory and degenerative type.



**untreated dental caries** = the main factor of pulpopathies of young permanent teeth → due to the possibility of faster action and evolution, due to the reduced thickness and the increased permeability of the dentin

- In the **first phase**, in the dentin and in the pulp, there are defense phenomena characterized by: the formation of sclerotic dentin (by intra- and pericanalicular calcifications at the level of the dentin) and the deposition of tertiary dentin at the pulpal level. By advancing the caries process, in the odontoblastic and subodontoblastic area, signs of chronic inflammation appear (mild vasodilation and the appearance of some defense cells). This stage is asymptomatic and reversible.
- The persistence of irritation factors, by not treating caries, leads to the proliferation of capillaries, fibroblasts, the appearance of lymphocytes and histiocytes with the **formation of granulation tissue** → asymptomatic and widely reversible stage, but the recovery is only partial due to the presence of fibrous scars sometimes with a wide tendency to diffuse calcification, which entails limiting the pulp tissue.
- **Finally**, by evolution → opening of the pulp chamber, followed by direct aggression of bacterial germs and toxins.
- This adds to the existing chronic inflammatory process with an acute process that precedes the formation, ultimately, of an abscess confined to the opening area and surrounded by granulomatous tissue.





## Dental trauma

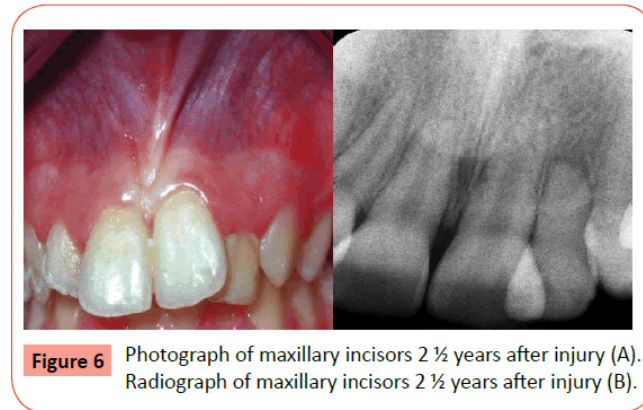
**Small and repeated traumas** caused by incorrect dental treatments (coronary fillings without base or in occlusion) and incorrect activation of orthodontic appliances (high forces) cause degenerative phenomena in the pulpal organ characterized by:

- reducing the number and size of all cellular elements (odontoblasts, fibroblasts, undifferentiated mesenchymal cells);
- quantitative increase of collagen, accompanied by partial calcification of the fibers;
- obliteration of the capillary network and thereby diminishing the blood supply to the pulpal organ;
- numerical reduction of nerve branches;
- increased deposition of secondary dentin.

All these processes that evolve insidiously, without clinical signs → finally → reducing the volume of the pulpal organ and decreasing the defense capacity of the pulpal structures.

Under these conditions, the addition of inflammatory processes → rapidly to extensive necrosis of the pulpal organ.

In most cases, regressive changes do not affect the apical territory, so root growth remains widely possible.



**Figure 6** Photograph of maxillary incisors 2 ½ years after injury (A). Radiograph of maxillary incisors 2 ½ years after injury (B).

## Classification of pulpopathies of young permanent teeth

*Kuntzel* classifies pulpal diseases into:

- pulpal hyperemia (all deep caries);
- asymptomatic or reversible pulpitis;
- symptomatic or irreversible pulpitis;
- pulpitis simultaneously symptomatic and asymptomatic (partially recoverable).

The traditional classification of *Euler and Meyer* which, using as a criterion the anatomical-clinical changes (symptoms and evolution) and the histopathological ones, at the level of the pulp, presents the following clinical forms:

- Acute pulpitis:
  - serous (partial; total)
  - purulent (partial; total)
- Chronic pulpitis:
  - closed
  - open (ulcerative; granulomatous - polyp)
- Pulp necrosis:
  - aseptic
  - septic (gangrene)

The modern classification recommended by Seltzer and Bender includes pulpal diseases in 2 major classes:

- reversible:
  - intact, non-inflamed
  - pulp partial pulpitis - acute or chronic, without necrosis
- irreversible:
  - chronic partial pulpitis with partial necrosis total
  - chronic pulpitis
  - total pulpal necrosis



# Diagnostic criteria

## Clinical steps:

- general and dental history (dental, pulpal);
- subjective and objective clinical examination (inspection, palpation);
- direct examination of the pulpal organ
  - vitality tests;
  - radiological examination.



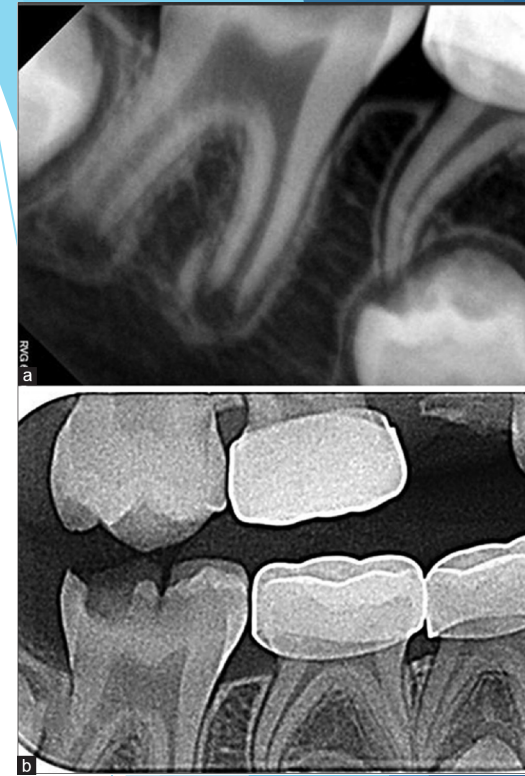
**Pain** is the **pathognomonic** symptom in any pulpal inflammation. In children, however, the psychological factor that imprints a personal interpretation of pain must be taken into account. Therefore, the analysis of pain in children is summarized in the following aspects:

- The presence or absence of pain, with its location on the right or left side of the face. But, while the presence of pain signals the presence of pulpal changes, its absence does not exclude pulpal changes;
- The nature of the pain: caused or spontaneous.
- The age of the painful sensations - indicates the degree of extension of the changes;
- The intensity of the pain and its character - lancinating, pulsating, irradiating or non-radiating.



## Radiological examination

- May confirm or refute the clinical diagnosis. An X-ray is required to assess the depth of caries, the thickness of the circumpulpal dentin layer, the proximity of the pulpal chamber lesion can not always be correctly interpreted on radiography. Often an intact secondary dentin barrier, evident on radiography, can actually be perforated due to irregular calcification and the underlying pulp is inflamed.
- *Internal resorptions* are not as common as in temporary teeth and pathological external resorptions appear as sequelae of periodontal ligament trauma (eg. in avulsions).
- *Therapeutically induced calcifications* (eg. by apexification) may sometimes be too low to be radiologically evident. In these cases, clinical testing, although risky, is necessary to confirm therapeutic success (calcified barrier formation).



## TREATMENT OF YOUNG PERMANENT TEETH PULPOPATHIES

The ultimate goal in the treatment of pulpopathies of young permanent teeth is to preserve all or part of the vitality of the pulpal organ necessary for the complete development of the root.

The recommended therapeutic methods in endodontic therapy of young permanent teeth are:

- Indirect or direct pulp capping - fully preserves the vitality of the pulp, based on the biostimulatory effect of calcium hydroxide;
- Pulpotomy - preserves only the root pulp - vital or mummified.
- Pulpectomy - complete removal of the coronoradicular pulp, preserving 6-8 mm of the apical third of the root branch and ensuring tight and biostimulatory closure of the root canal with calcium hydroxide paste, until the apex is built.



## Indirect pulp capping

**!!!! not every application of calcium hydroxide over softened infected dentin is an indirect pulp capping.**

indirect pulp capping = only in cases where the softened dentin is completely removed from the walls of the cavity, leaving only a limited area on the parapulpal wall so as not to open the pulp chamber.



- integral preservation of pulpal vitality;
- neodentinogenesis on the parapulpal wall;
- correct treatment of the dentinal wound and sealing of the dentinal canals;
- ad integrum healing of incipient and reversible pulpal inflammation.



Indications	Contraindications
young permanent teeth with deep carious processes;	partial or total purulent pulpitis, total serous pulpitis, chronic pulpitis;
young permanent teeth with clinical symptoms of pulpal hyperemia or partial serous pulpitis.	general debilitating conditions that diminish the potential for pulpal healing.



### **Technique:**

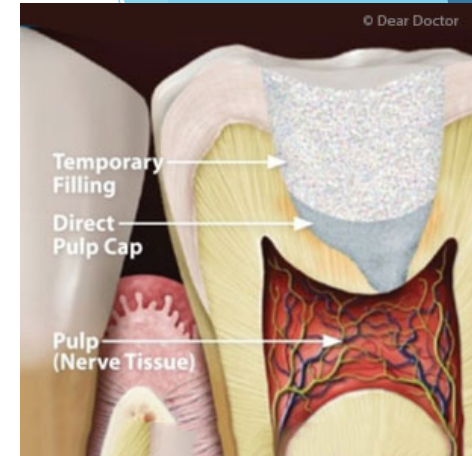
- tooth anesthesia;
- perfect insulation of the tooth (especially important not to further contaminate the pulp with bacteria from saliva);
- opening the carious lesion and removing the softened dentin until the walls of the cavity are clean, except for the parapulpal wall where the softened dentin can be kept punctiform near the pulpal horn, if there is a risk of its opening by its excision;
- dentinal wound toilet with sterile isotonic solutions (saline, distilled water, xylin);
- drying with carbonized pellets or hot air;
- application of a 1 mm layer of calcium hydroxide on the entire pulp wall;
- filling the crown with high-strength cements (glass ionomer, polycarboxylic zinc phosphate) that allow the tooth to be dispensed for a longer period of time (6-8 weeks).



## Direct pulp capping

*the purpose* → to induce the repair of the breach by calcification and the preservation of the integral vitality of the pulp.

= therapeutic work consisting in the application of a biocompatible material with healing action, in direct contact with the exposed vital pulp.

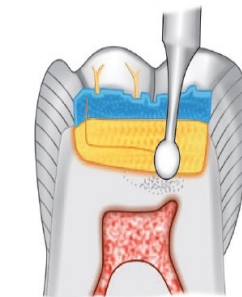


Indications	Contraindications
Accidental opening of the pulp chamber during cavity preparation. The opening must be small in size (less than 1-2 mm), surrounded by healthy dentin, and the tooth must be completely isolated from saliva and without a painful history.	Young permanent teeth with pulpal pathology and painful history (total serous and total purulent pulpitis, chronic pulpitis);
Small carious opening in a permanently young tooth that has no history of spontaneous pain, swelling, radiological signs of pulpo-periodontal damage, or uncontrollable bleeding at the opening.	Teeth with pulpal pathology and dental mobility;
Coronary fracture with pulpal exposure not exceeding 2 mm and provided it is recent (several hours).	Pulpal exposure greater than 2 mm and older than 6 hours;
	General conditions: discolagenosis, dysmetabolism, etc

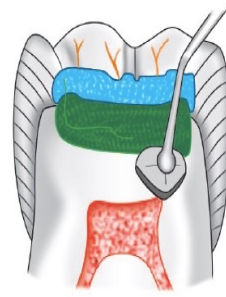


## Technique:

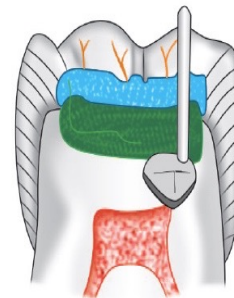
- tooth anesthesia;
- perfect insulation of the tooth (especially important not to further contaminate the pulp with bacteria from the saliva);
- excision of the dentin softened from the lateral walls of the cavity to healthy, normally colored, glossy tissue. Finally, with sterile hand tools (well-sharpened excavator), remove the softened dentin from the parapulpal wall as much as possible and quantify the pulpal exposure from the point of view of:
  - dimensional - point opening of 1-2 mm diameter;
  - coloristic - lively, red pulp;
  - of bleeding - limited bleeding, bright red;
- washing the cavity with saline or distilled water and stopping the bleeding by lightly compressing with sterile cotton balls;
- treatment of dentinal and pulpal wounds using preparations based on calcium hydroxide, possibly preceded by a dressing with antibiotics and hydrocortisone for 24-48 hours;
- application without pressure of the therapeutic filling (frequently ZOE cement with quick setting);



**A** Remove the caries with a slow-speed bur



**B** Place calcium hydroxide over the exposed pulp



**C** Direct pulp capping

# Pulpotomy

- the therapeutic method by which the coronary pulp is partially or totally amputated and the vital root pulp abutment is covered with calcium hydroxide or other mummifying material (formocresol), which allows the building of the apex in the best conditions.



Indications	Contraindications
in pulpal exposures greater than 2 mm or older than 6 hours, with minimal or limited pulpal inflammation only in the pulpal territory;	clinical or radiological signs of total pulp involvement (total purulent pulpitis, necrosis, gangrene) or pulpo-periodontal damage;
failures of the therapy of integral preservation of the pulp by capping;	uncooperative patients;
in all forms of acute inflammation (pulpal hyperemia, partial serous pulpitis, partial purulent pulpitis);	congenital heart disease or rheumatoid fever to avoid any possible residual infection that is a source of bacteremia;
	general debilitating conditions that decrease the potential for defense and regeneration.

## Partial pulpotomy - high (Cveck)

= special pulpotomy technique that involves removing only a limited portion of the coronary pulp.

### Technique

- the tooth is anesthetized;
  - perfect insulation is ensured (dam);
  - the carious tissue is removed with excavators or large globular cutters, at low speed, until pulpal exposure occurs;
  - carefully remove infected pulpal horns;
  - after stopping the bleeding, pure calcium hydroxide is applied to the exposed pulpal surface, taking care not to interpose a blood clot;
  - the coronary cavity is then restored and the tooth is followed clinically and radiologically;
- ✓ If successful, the tooth should remain asymptomatic, and the radiograph should show the formation of a secondary dentin barrier.

## Partial pulpotomy with trichresolformaline

=indicated as a necessity (emergency) treatment for young permanent teeth with partially vital or devital pulp, when endodontic therapy cannot be applied for psycho-social or economic reasons.

The **technique** is similar to that of temporary teeth except that the bullet with tricresolformaline is left permanently in the pulp chamber. Vital teeth treated with this technique show a postoperative sensitivity (24 hours) that can be controlled with analgesics. The procedure is used as an alternative to extraction and does not replace conventional endodontic treatment.

## Vital Pulpotomy with Calcium Hydroxide

= the method of choice for young permanent teeth with vital root pulp.

The purpose → to remove the inflamed coronary pulp and to maintain the vitality of the root pulpal tissues to allow the complete edification of the root.

### *Technique*

- anesthesia and perfect isolation of the tooth;
- removal of unsupported enamel prisms and softened dentin from the side and parapulpal walls of the cavity;
- removal of the pulp chamber ceiling;
- ablation of the coronary pulp either with a well-sharpened excavator or more correctly with a diamond spherical cutter. The level of amputation usually corresponds to the enamel-cement junction. Washing the pulp chamber with distilled water or saline in order to remove pulp residues and dentin powder;
- stopping the hemorrhage at the level of the amputation surface by applying sterile, carbonized cotton balls.
- If it is not possible to stop the hemorrhage in 2-5 minutes (due to the inflammatory vasodilation in the root pulp), try either the temporary application (5 minutes) of a bullet with tricresolformaline (which will fix the remaining pulpal tissues) or continue the partial ablation of the pulp root.
- Applying a layer of calcium hydroxide on the amputation surface and on the floor of the pulp chamber, which is sealed with a layer of fast-setting zinc eugenate, of soft consistency and without exerting pressure, and when it has completely hardened, the tooth is restored coronary .



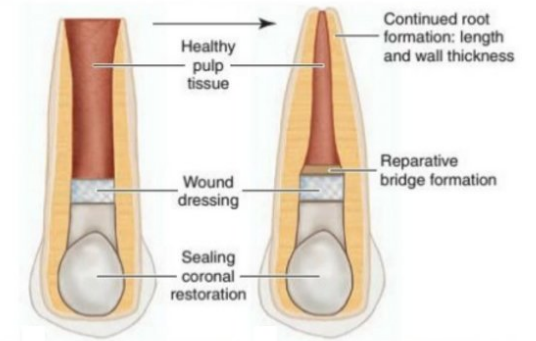
## Apexogenesis

= therapeutic method by which the techniques described above (pulp capping, pulpotomies, partial pulpectomies) aim to maintain pulpal vitality, at least in the apical area, to allow further root growth and closing the apex of young permanent teeth.

- ✓ Used in young permanent teeth in which the pulp is totally or partially vital.
- ✓ The success of the method is highlighted clinically and radiologically by:
  - absence of spontaneous pain;
  - absence of pain on axial percussion;
  - absence of soft or bone changes (fistulas, radiolucency);
  - continued root formation and complete closure of the apical area.
- ✓ The prognosis of apexogenesis is favorable, the final result being a normal root and apex in size, shape and length.

When the root growth is finished, and the limiting walls of the apex have become convergent, building the apical third, it is possible to move to hermetic, non-absorbable root fillings, with paste and gutta-percha cone, by the lateral or vertical condensation technique.

### Apexogenesis



## *Frank's technique for apexification*

= the process by which in the root canal and in the periapical tissues, after the necrosis of the pulp, the formation of a hard tissue barrier (osteoid or cementoid), is wanted to ensure the sealing and isolation of the root territory.

- ✓ at devital young permanent teeth → leads to flattening of the end of the root and the formation of a shorter root.
- ✓ Frank paste: calcium hydroxide + Walchoff paste + methylcellulose

### *Technique:*

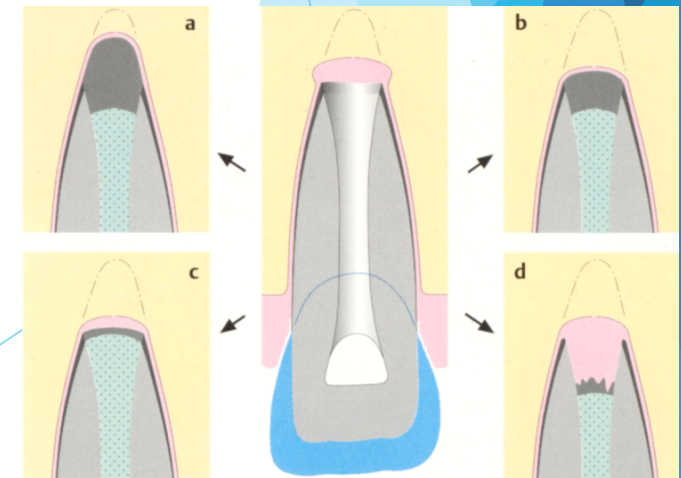
- mechanical treatment that ensures the permeability of the root canals and the highlighting of the gangrene content; Mechanical treatment (with Headstrom needles) should stop 2 mm from the radiological apex (preoperative radiography is mandatory) to avoid trauma to the apical region and pushing of the necrotic tissue through the wide apex.
- the action of the mechanical treatment is completed with endocanal washes with 2.5% sodium hypochlorite solution alternating with hydrogen peroxide - which allow the evacuation of the scraping products;
- disinfection and sterilization of infected canals;
  - There are 2 ways to follow: either after 2-3 sessions of antiseptic dressing (bullet with Walchoff solution in the pulp chamber), insert Frank paste (calcium hydroxide and Walchoff paste) or Walchoff paste or paste with calcium hydroxide (HYPOCAL); or, preferably, ocalexic therapy is applied and the CaO-based paste is inserted.
- the tooth is temporarily sealed with a fast-setting, eugenol-free cement.



- ✓ Furthermore, due to the high degree of resorption, the therapeutic filling with calcium oxide or hydroxide must be renewed every 3-4 months.
- ✓ The apical barrier must be checked for each replacement of calcium hydroxide. Because it is fragile in the early stages, we do not recommend the use of canal needles, but a gutta-percha cone.
- ✓ In addition to this clinical control, a radiological control is performed once every 6 months until the formation of the apical barrier (6-24 months, sometimes even longer).
- ✓ The success of the intervention will be demonstrated by sealing the root canal, visible on successive radiological clichés and by clinical examination.

The following situations are possible:

- the root continues to form and a hard tissue bridge appears;
- shortened root, with the formation of a bridge of hard tissue at the entrance to the canal;
- formation of a thin barrier, not radiologically detectable;
- growth of the periapical connective tissue in the canal and its partial calcification.



## Devital anterior teeth bleaching in young patients

- ✓ Pulpal diseases cause coloration of the dental crown -> in young permanent teeth, due to the thin layer of hard dental tissue and wide dentinal canals
- ✓ However, the same peculiarities lead to obtaining favorable results in trying to bleach these teeth.
- ✓ The essential condition for teeth whitening therapy = a tight endodontic obturation.

### Technique:

- isolate the tooth (preferably with the dam);
- the coronary filling material is removed as much as possible from the colored dentin, without undermining the crown too much;
- the root filling is removed to the CEJ and then a 1-2 mm layer of zinc phosphate cement is applied to prevent the bleach from infiltrating into the fixed gum, via the dentinal canals.
- phosphoric acid is applied to the dentin to open the dentinal canals;
- the bleaching agent (30% hydrogen peroxide solution) is then applied both inside the crown and on its surface. To amplify the effect of the whitening agent, heat the tooth or apply UV light for 5-10 minutes.
- the procedure is repeated 3-4 times, leaving in the pulp chamber for 3-5 days a ball soaked in 30% hydrogen peroxide solution (the pulp chamber is sealed with phosphate cement);
- subsequently the cavity is closed with a light shade of composite.

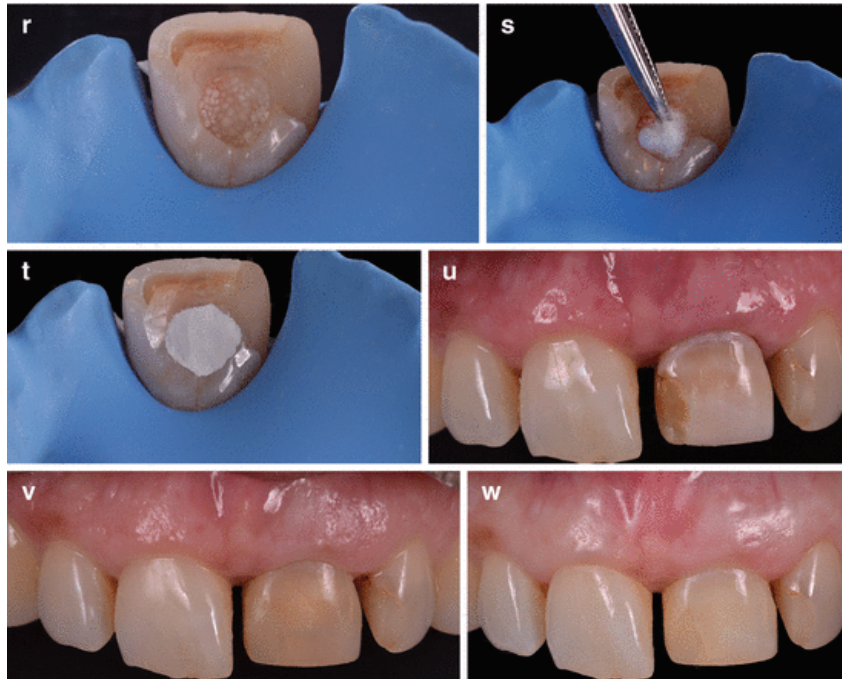
!!! The most common complication = the appearance of cervical resorptions due to the infiltration of the hydrogen peroxide solution. To prevent this, the use of milder bleaching agents such as sodium perborate is recommended.



Before



After



## External Root Resorption

Before Bleaching



2 Years After Bleaching





