Pulpal Reactions To Dental Procedures

What Is The Pulp
- Connective tissue uniquely situated within the rigid encasement of mineralized dentin

What Is Found In The Pulp Chamber
- Nerves
- Vascular tissue
- Fibers
- Ground substance
- Interstitial fluid
- Odontoblasts
- Fibroblasts
- Minor cellular components

Functions Of The Pulp
- Formative
- Repair
- Nutrition
- Sensory
- Protection/Defensive

Why The Pulp Is Unique
- Pulp is enclosed by rigid mineralized dentin =1's a low-compliance environment
- Microcirculatory system-lacks a true collateral blood supply
- Potential for regeneration and repair diminishes as we age
- Very sensitive to thermal stimuli
- Ability to form dentin throughout life
Relationship Of The Pulp To Dentin

- Permeability properties of dentin regulate the rate of diffusion of irritants that initiate pulpal inflammation
- Odontoblasts are arranged peripherally in direct contact with dentin matrix
- This close relationship between the dentin and pulp create a functional unit called the PULPODENTIN COMPLEX

Dentinal Tubules and Permeability

- S-shape as they curve from DEJ to the pulp
- Inverted cone shape with smallest dimensions at the DEJ and largest dimensions at the pulp
- Transverse entire width from DEJ (DCJ) to the pulp
- Slightly tapered with wider portion toward the pulp (3um vs .8 um)
- Number of tubules increases from DEJ to pulp (15,000 vs 65,000/sq mm)

Dentin Tubules and Permeability

- Because both the density and diameter of the tubules increase with dentin depth from the DEJ, the permeability of dentin is lowest at the DEJ and highest at the pulp
- Axial dentin is more permeable than occlusal dentin
- Surface area of full crown preparation 1 cm² exposes 4 million dentinal tubules on a posterior tooth
Another Variable-RDT

- RDT-remaining (residual) dentin thickness
- In human teeth, dentin is, on average approximately 3 mm thick
- Dentin permeability increases with decreasing RDT
- RDT of 2mm or more effectively precludes restorative damage to the pulp
- .75 mm-effects of bacterial invasion seen
- .25mm-odontoblastic cell death

How The Pulp Reacts To Caries

- Decrease in dentin permeability
- Tertiary dentin formation
- Inflammatory and immune reactions

How The Pulp Reacts To Restorative Procedures

- Cumulative effect of caries, microleakage, restorative procedures and restorative materials
**Effect Of Local Anesthetic On The Pulp**

- Vasoconstrictor of LA’s potentiate and prolong anesthetic effect by reducing blood flow in the area
- LA with epi can significantly decrease pulpal blood flow
- Reduction in blood flow during a restorative procedure could lead to an increase in the conc of irritants accumulating within the pulp

**Cavity and Crown Preparation**

- Pulpal responses depend on many factors:
  - thermal injury
  - transection of odontoblastic process
  - vibration
  - dessication of dentin
  - pulp exposure
  - smear layer
  - RDT
  - agents for cavity cleansing, drying, sterilizing and acid etching

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**Thermal Injury**

- Frictional heat—the production of heat within the pulp is the most severe stress that restorative procedures impart on the pulp
- Amount of heat produced depends on speed of rotation, size and shape of the cutting instrument, length of time in contact with dentin, amount of pressure exerted on handpiece and if water-air spray is used
- Temp raised 10 degrees above ambient temp; cell death occurs

**Thermal Injury**

- "Blushing" of teeth during or after cavity or crown prep is attributed to frictional heat
- Pink or purple color due to vascular stasis of subodontoblastic capillary plexus blood flow which rupture and release RBC's

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*Fig 15-6 Pulpal hemorrhage associated with crown preparation. (a) Maxillary central incisor immediately after crown preparation. (b) One week later, showing dental discolation as a result of intrapulpal hemorrhage. (c) Histologically, displacement of odontoblast cell bodies into tubules and intrapulpal hemorrhage indicate irreversible pulpal damage (M&L stain, original magnification X250).*
Transection Of The OP

- OP may extend all the way from the odontoblastic layer to the DEJ
- Cutting of the OP close to the cell body may result in irreversible injury
- >'s permeability
- **death of odontoblasts also due to frictional heat, vibration, dessication, bacterial toxins and chemical irritants

Crown Preparation

- Pulp necrosis with full crown prep = 13.3%
- PN with partial veneer prep = 5.1%
- PN with core build-ups = 17.7%

Vibratory Phenomena

- Particularly when cutting speed is reduced
- “Shock-wave” phenomena
- Disruption of odontoblastic cell layer or death of odontoblastic cell(s)

Dessication Of Dentin

- Drying of cut dentin with a jet of air produces a rapid outward movement of fluid through the dentinal tubules
- Not only does this stimulate sensory nerve fibers (pain), this fluid movement may “draw” odontoblasts up into the tubules resulting in cell death

Pulp Exposure

- Mechanical vs bacterial
- Injury to pulp due to bacterial contamination
Smear Layer
- Layer of organic and inorganic debris
- To remove or not?
- Removal may increase dentin permeability
- Bacteria in smear layer may be a problem

RDT
- Ideal is 2mm
- Dentin permeability increases logarithmically with increasing cavity depth due to the difference in size and number of dentinal tubules

Agents For Cavity Cleansing, Drying, Sterilization and Acid Etching
- Incidence of pulpal inflammation can increase significantly

Other
- Impression taking-heat and pressure
- Insertion and cementation-hydraulic forces may compress fluids in the dentinal tubules resulting in separation of the odontoblastic layer from the dentin
Restorative Materials

• Effect pulp due to:
  - chemical toxicity
  - acidity
  - absorption of water during setting
  - poor marginal adaptation resulting in bacterial contamination

Current Thinking

• Past-pulpal rxs to dental procedures due to mechanical insults such as frictional heat
• Past-pulpal rxs to dental materials due to chemical effects esp with little RDT
• Now-pulpal injury due to “microleakage” of bacteria through gaps between filling materials and walls of the cavity

Routes Of Microleakage

• Within or via the smear layer
• Between the smear layer and the cavity varnish/cement
• Between the cavity varnish/cement and restorative material

How The Pulp Responds

• Dentin sclerosis
• Reparative dentin
• Blood flow changes-Arteriovenous anastomoses (AVA’s)-blood is shunted away from capillaries
• Inflammatory/immunological phenomena
How The Pulp Recovers

• As tissue pressure increases from increased blood flow, AVA’s open and shunt blood before it reaches an inflamed region, thus preventing a further increase in blood flow and tissue pressure.
• Increase in tissue pressure pushes macromolecules back into bloodstream via venules in adjacent healthy pulp.
• Once macromolecules and excess fluid leave the extracellular tissue space via venule, tissue pressure decreases and normal blood flow is restored.

How To Minimize Pulpal Injury

• Cutting procedures: use light, intermittent cutting, efficient cooling and high speeds of rotation (4 secs on 1 sec off).
• Avoid dessicating dentin-do not overdry cavity prep.
• Do not apply irritating chemicals to freshly cut dentin.
• Choose restorative materials carefully, considering the physical and biological properties of the material.
• USE RUBBER DAM.

How To Minimize Pulpal Injury

• Do not use caustic sterilizing agents.
• ASSUME THAT ALL RESTORATIVE MATERIALS LEAK. Use cavity liners or base to seal the openings of dentinal tubules.
• Do not use excessive force when inserting a restoration.
• Employ polishing procedures that do not subject the pulp to excessive heat.

How To Minimize Pulpal Injury

• Establish a patient recall system that ensures periodic evaluation of the status of the pulps that have been exposed to injury.