The Effects of Temperature on Sodium Hypochlorite Short-Term Stability, Pulp Dissolution Capacity, and Antimicrobial Efficacy

By: Kimberly Hawrylyshyn

Introduction

- Sodium hypochlorite was first introduced as an antiseptic in WWI by Henry Dakin
- Today NaOCl is the favoured root canal irrigant
  - Favourable antibacterial, tissue-dissolving and lubricating properties
  - Good shelf-life, low cost, easily available
- Some debate as to the ideal concentration of NaOCl
  - Antibacterial, tissue-dissolving and toxic effects increase with increasing concentrations
  - Trade-off between beneficial irrigant effects and caustic potential
- Heating low concentration NaOCl is an alternative to increasing concentration to improve effectiveness
  - Improves immediate tissue-dissolution capacity
  - Systemic toxicity is lower than higher concentration NaOCl
  - Few studies available investigating the chemical stability, antimicrobial properties and tissue dissolution of heated NaOCl
  - Heating devices for irrigation solutions are available on the market
- Purpose of this In vitro study is to investigate:
  - Short-term chemical stability of pre-heated NaOCl
  - Compare dissolution capacities of NaOCl solutions on human pulp specimens at different temperatures
  - Assess efficacy of pre-heated NaOCl solutions on *E. faecalis* (a species associated with failed endodontic treatment)

Material and Methods

- Solutions
  - 1%, 2.62%, 5.25% solutions were used
  - Protected from oxidation in tightly covered amber glass bottles stored at 5°C
- Temperature
  - NaOCl solutions were heated to 45°C and 60°C in a syringe warming device
  - Calibrated electronic thermometer was used to measure irrigant temperature
- Short term NaOCl stability
  - Chemical stability was assessed by measuring the amount of chlorine in solution over time
  - Measure using standard iodine/thiosulfate titration method
Measurements were taken twice at 15, 30 and 60 mins

- Tooth collection
  - 22 teeth (10 molars, 12 premolars)
  - Extracted for orthodontic purposes

- Tissue dissolution assay
  - Pulp tissue was extracted from teeth and placed in 0.9% saline solution
  - 5 pulp specimens were used per irrigating solution
    - 1% NaOCl at 20°C
    - 1% NaOCl at 45°C
    - 1% NaOCl at 60°C
    - 5.25% NaOCl at 20°C
  - Mesh was preweighed
  - Pulp specimens were laid on a round polyethylene mesh with a pore size of 0.5mm which was placed on a moistened filter paper with a pore size of ≤30µm in a Buchner filter funnel mounted on a flask connected to a vacuum pump
  - Pulp specimens were irrigated with 5mL of solution for 60s
  - Mesh containing pulpal tissue was removed and weighed
  - Results were reported as a percentage of the initial pulp tissue remaining after irrigation

- Antimicrobial test
  - *E. faecalis* ATCC 29212 cell were cultured in tryptic soy broth for 48h at 37°C
  - Cells were rinsed with phosphate buffered saline (PBS) and harvested by centrifugation and suspended in PBS
  - Test solutions were prepared and heated to 45°C or 20°C
    - NaOCl: 0.001%, 0.0001%, 0.00001% (wt/vol)
  - 10µL of bacteria in PBS were added to 890 µL of solution and incubated for 10 minutes at the respective temperatures
  - Sodium thiosulfate was added to stop the microbial activity
  - A 10-fold dilution series was made in PBS
  - Droplets of 20µL were cultured on tryptic soy agar for 48h at 37°C and colonies were counted

Results

- NaOCl remained chemically stable for the entire 60 min duration of the experiment
- Percent of dissolved tissue was greatest for 1% 60°C NaOCl solution
- The antimicrobial efficacy of NaOCl was roughly 2 orders of magnitude higher at 45°C compared to 20°C

Discussion

- Study corroborated findings:
- NaOCl is heat stable for a clinically relevant period of time
- Improved tissue dissolving capacity
- Improved antimicrobial activity
  - In vitro experiment may not be directly extrapolated to clinic situation
  - Unclear whether preheated solutions are less toxic than higher concentration solutions
  - Heat transfer may affect periodontal tissue
    - Human dentin has low thermal conductivity
    - Surrounding tissues heat to dissipate heat
    - Expected that irrigating solutions would reach equilibrium temperatures relatively quickly
  - More studies are necessary to determine the ideal temperature
  - Chair side heating devices can warm irrigant to desired temperatures in a relatively short period of time from stock solutions
  - Studies found a temperature increase of 25°C increased efficacy by a factor of 100 against *E. faecalis*
    - Increase antimicrobial efficacy is present with other irrigants such as chlorhexidine gluconate

**Conclusion**

- Preheating NaOCl increases tissue dissolution and efficacy against *E. faecalis*
- NaOCl can be heated chair side from stock solution relatively quickly using warming devices
- NaOCl remains chemically stable at temperatures up to 60°C for up to

1-hour Reference