

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

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Introduction

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

Material and Methods

- Solutions
 - o 1%, 2.62%, 5.25% solutions were used
 - o Protected from oxidation in tightly covered amber glass bottles stored at 5°C
- Temperature
 - o NaOCl solutions were heated to 45°C and 60°C in a syringe warming device
 - o Calibrated electronic thermometer was used to measure irrigant temperature
- Short term NaOCl stability
 - o Chemical stability was assessed by measuring the amount of chlorine in solution over time
 - o 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 $\leq 30\mu\text{m}$ 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)
 - 10 μL 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 20 μL 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

Sirtes G, Waltimo T, Schaetzle M, Zehnder M. The Effects of Temperature on Sodium Hypochlorite Short-Term Stability, Pulp Dissolution Capacity, and Antimicrobial Efficacy. J Endod. 2005;31(9) 669-671