

Determining the Best Location for Cold Test Based on Response Time in Anterior Teeth Using Various Applicators: An *in-vivo* Study

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ABSTRACT

Although the cold tests have been used to supplement the diagnosis over the years in clinical practice, there are no exact locations that have been cited in literature where the stimulus can generate fastest and accurate response in anterior teeth. Various authors have suggested different sites to perform a cold test however this has not been standardised thus making it the need for the study.

Aim: To determine the best location to perform a cold test on anterior tooth and to compare endofrost with ice-sticks based on the response time.

Setting and design: An *in vivo* study was performed on 20 subjects in the age groups of 20-40.

Methods: The labial surface of the anterior teeth were divided into three parts cervical, middle, incisal third. The cold test was performed with ice-sticks. The patients were instructed to raise a hand when they experienced a sensation and time was noted using a stopwatch. After giving a gap of 5 minutes for each teeth to recover the cold test was carried out with endofrost on the same subjects. The test was performed with both large #2 cotton tip applicators and small #4 cotton tip applicators and checked for response time following which the mean time taken to respond was calculated and ANOVA with tukeys post hoc analysis was done.

Conclusion: Within the limitations of this study, we can conclude that endofrost is the faster method to do a cold test when compared to ice sticks. Cervical third is the appropriate site to perform cold test with ice-sticks for anterior teeth. With endofrost middle third is the faster to perform cold test. Larger the size of cotton tip applicator faster is the response when performing the cold test.

Keywords: Cold test, Cotton tip applicators, Endofrost, Ice-sticks, Vitality test

INTRODUCTION

Pulp sensibility test is one of the crucial facets in determining the health status of dental pulp. It provides a valuable treatment planning information to the dental clinician and thus complements the endodontic diagnosis. These tests might give false

positive results leading to incorrect, inappropriate, or unnecessary treatment and thus they should be properly carried out⁽¹⁾. Thermal tests using cold as stimulus are most commonly used in clinical practice. Although the tests have been used to supplement the diagnosis over the years in

clinical practice, there are no exact locations that have been cited in literature where the stimulus can generate fastest and accurate response in anterior teeth. Thus establishing a need for this study. So this study was employed to check the appropriate site to perform a cold test on anterior tooth and to compare endofrost with ice-sticks based on the response time.

There are various methods employed to use endofrost but there is no study which standardises the size of cotton tip applicators that can be used with endofrost. Thus this study also determined if there was an effect on the response to cold test based on the size of cotton tip applicators used.

Aim

The aim of this in vivo study was to determine

1. Fastest response for cold test between endofrost and ice-sticks.
2. Appropriate site to perform a cold test on anterior teeth for endofrost and ice-sticks
3. If the size of cotton tip applicator had an effect on the response time.

SUBJECTS & METHODS

An in-vivo study was performed following the approval of ethical committee and after obtaining the consent from the subjects. A total of 20 subjects in the age groups of 20-40 years were considered in the study. The tooth tested were incisors and canines.

The inclusion criteria were subjects:

- Having sound anterior teeth with no restorations or teeth requiring endodontic treatment
- Who have not been diagnosed with systemic diseases
- Who have not taken any medications 24 hours before the start of the study

The exclusion criteria were subjects:

- Undergoing orthodontic treatment.
- Have had traumatic injuries within last six months.

The subjects were blindfolded. The tests were performed by a single clinician to

avoid any bias. The tests were conducted as follows:

1. Cold test with ice-sticks

2ml of anaesthetic carpule was filled with water and placed in refrigerator to form an ice-stick. The ice-sticks obtained were of 3.5mm diameter and 7mm length. The teeth were isolated with rubber dam for cold test with ice-sticks. The labial surface of the anterior tooth of the patient was divided into three parts cervical, middle, incisal third. While performing the tests ice-sticks were placed in gauze to prevent the warmth from operator's fingers prematurely. Then the ice-sticks were placed on the labial surface of the tooth in the cervical third of the tooth following which the timer was set. The patients were instructed to raise one hand when they experienced a sensation and time was noted using a stopwatch. For the pulp to recover there was a 5-minute gap given for each site while performing the test and then similarly the procedure was followed on middle third and incisal third of the tooth.

2. Cold test with endofrost

Cold tests were performed with Endofrost (-50 degrees Celsius, Coltene/Whaledent that contains propane, butane, isobutane) on the same subjects after allowing the pulp to return to its normal state. The teeth were isolated using cotton rolls and gauze pieces. The labial surface of the tooth to be tested was divided into three parts incisal, middle, cervical third. Large cotton pellets of size #2 were held with a pair of stainless steel cotton pliers and endofrost was sprayed on cotton pellets directly with distance of 5.0 mm for a period of 5s. This allowed the cotton pellet to become saturated to the point where the frost was dripping from the pellet. The pellet was then placed on the cervical third of the tooth (for 5 seconds or till the patient felt any sensation) and timer was set. The patient was instructed to raise a hand when a cold sensation was felt and time was recorded using a stop watch. A gap of 5 minutes that allowed the recovery of pulp was given and then the above procedure was carried out in middle third and incisal third respectively ⁽²⁾.

The labial surface of the teeth was divided into incisal, middle and cervical thirds and cold test was carried out with endofrost spray and small cotton pellets of size #4 as mentioned above in all the thirds of the tooth with a gap of 5 minutes and the response time was noted.

The appropriate location to perform a cold test was based on response time.

STATISTICAL ANALYSIS

1. The time taken to respond to tests were noted and mean was calculated
2. Comparison between the groups after mean was obtained and ANOVA with tukeys post hoc analysis was done

RESULT

Table 1: Average time range taken by the subjects to respond to cold test with ice-sticks

Different thirds of the teeth	Average time taken to respond (in seconds)
Incisal third	4.5
Middle third	3.4
Cervical third	3

The time taken to respond to cold test with ice-sticks was least in the cervical third and the results are statistically significant ($P < 0.05$ p-value is .0001)

Table 2: Average time range taken by the subjects to respond to cold test with endofrost

2a: Average time range taken by the subjects to respond to cold test with endofrost with #2 cotton tip applicator

Different thirds of the teeth	Average time taken to respond (in seconds) with large #2 cotton tip applicator
Incisal third	3.2
Middle third	2.3
Cervical third	2.6

2b: Average time range taken by the subjects to respond to cold test with endofrost with #4 cotton tip applicator

Different thirds of the teeth	Average time taken to respond (in seconds) with small #4 cotton tip applicator
Incisal third	4.5
Middle third	2.5
Cervical third	3.1

The time taken to respond to cold test with endofrost was least in the middle third when done with both small and large cotton tip

applicators (#2 and #4) and the results were statistically significant ($P < 0.05$ p-value is .000153)

On comparing Table1 and Table2a it was found that the time taken to respond to endofrost was least when compared to ice-sticks and the results were statistically significant ($P < 0.05$ p-value is .017723)

On comparing Table2a and Table2b it was seen that the time taken to respond to endofrost was least with large #2 cotton tip applicator when compared to small #4 cotton tip applicator

DISCUSSION

Stimulation of pulp with thermal tests is one of the oldest methods to evaluate health of pulp and its ability to respond to external stimulation. Records including Edwin Smith Surgical Papyrus have referred to use of cold stimulus as a form of pulp testing since 2500BC⁽³⁾. Several methods such as ice-sticks, refrigerant sprays, carbondioxide snow, ethylchloride are available with major difference between them being temperature produced by each method⁽⁴⁾. In general the response to cold test is measured as positive or negative reaction but the quality of response is also important⁽⁵⁾. In this study the sound teeth were considered to avoid any false positive or negative responses due to compromised pulpal response that can be seen in cases of trauma, usage of certain drugs etc.

Ice sticks have been used as media for cold test. It has been indicated that application of ice stick for a period of 5 seconds is reliable and valid method⁽⁶⁾. In this study the fastest response was seen in cervical third with ice-sticks where the mean time taken to respond by patients was 3 seconds compared to the time taken by the patients to respond in the incisal and middle third thus suggesting that this could be the best site for performing cold test. This can be attributed to the layer of enamel thickness which is less on cervical third of teeth thus generating a quicker response from dentin.

Studies have indicated that thermal tests are more accurate when placed on the cervical

third of the labial surface because this location represents the thinnest aspect of the enamel and the closest distance to the pulp chamber⁽⁷⁾. Cold response appears to relate directly to the thickness and type of tooth structure (enamel or dentin) between the source of the cold and the pulp. However other studies conducted suggest that ice-stick is simply not cold enough and other methods like refrigerant sprays are more reliable when compared to ice-sticks^(8, 9). Also studies suggest that the melting ice might stimulate nerves within surrounding gingiva of tooth being tested or adjacent teeth or nearby teeth, which can result in false response that may lead to incorrect diagnosis⁽²⁾. Our results are in accordance with studies done which indicate that refrigerant ice sprays are highly sensitive when compared to ice-sticks as the response with endofrost was faster compared to ice-sticks⁽¹⁰⁾.

The use of refrigerant sprays is that it is relatively cheap and can be used easily in a clinical setup⁽¹⁾. In this study endofrost was sprayed on cotton pellets the patients took an average time of 2.3 and 2.5 seconds to respond in the middle third (with large and small cotton tip applicators respectively) when compared to cervical and incisal thirds. As it suggests middle third gave a quickest response, thus middle third is the appropriate site to perform cold test using endofrost. This can be explained by the hydrodynamic theory concerning the sensory response of tooth to thermal stimulation. Application of heat and cold results in the rapid movement of dentinal fluid that mechanically stimulate the sensory terminals located in the region of PDJ. This response is due to rapid temperature change that causes sudden fluid flow in dentinal fluids and deforms the cell membranes of free nerve endings. Based on hydrodynamic theory outward movement of dentinal fluid caused by (contraction of fluid) application of cold produced stronger response in a delta fibres than the inward movement of fluid caused by application of heat^(11,12). The cervical third may give false

positive response. The thermal tests are effective if a sufficient amount of osmotic changes take place within tubules and tubules get narrower as we move incisally with lesser fluid thus it takes greater time to respond to the test. Thus, this explains that middle third is appropriate site to perform a cold test with endofrost. Our study found similar results to previous studies conducted who also suggests that middle third is the appropriate site to perform a cold test with refrigerant sprays^(13, 14).

The greatest time to respond to cold test was taken in the incisal third of the tooth surface. Researchers have reported high and low values of sensitivity, specificity, accuracy, positive predictive value and negative predictive value with cold and electric tests in the incisal third of the tooth surface⁽¹⁴⁾. Demirci and Roh D et al have reported high frequencies of caries, restorations, enamel loss (abrasion) and exposed dentin on the incisal third of the tooth and suggest all these clinical pathologies are associated with false results when using pulp sensibility tests and thus this suggests incisal third might not be an appropriate site for performing the cold test^(15, 16).

In this study it was seen that larger the cotton tip applicator, faster is the response at all the three sites cervical third, middle third and incisal third. This could be explained by the theory that the smaller cotton tip applicator had smaller surface area hence it did not wet enough the tooth with refrigerant spray to generate the delayed response. It should also be known that the same large cotton pellet cannot be applied twice while performing tests. Studies performed by Garza et al and Jones also showed that when the refrigerant spray was used, larger cotton carrier generally produced the largest decrease in pulpal temperature at each repeated application compared to other types of carriers^(17, 18).

Various authors have suggested different sites for performing the cold test for different teeth. In this study, only anterior teeth of the subjects were taken into

consideration. Thus more studies need to be done in future to confirm the appropriate sites for performing the cold test even in premolars and molars. Studies have also shown the difference in the pulp sensibility test responses between the normotensive and hypertensive patients which can also be considered as a future scope in this regard (19).

CONCLUSION

Within the limitations of this study, we can conclude that

- ❖ Endofrost is a faster method to do a cold test when compared to ice-sticks.
- ❖ Cervical third is the appropriate site to perform cold test with ice-sticks.
- ❖ With endofrost middle third is the appropriate site to perform cold test in anterior teeth.
- ❖ Larger the size of cotton tip applicator faster is the response when performing the cold test.

Declaration by Authors

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