

DIAGNOSTIC ACCURACY OF COLD TEST AND ELECTRIC PULP TESTING FOR TESTING PULP VITALITY IN SINGLE ROOTED TEETH WITH IRREVERSIBLE PULPITIS

Mashal Zeb Jan¹, Sonia Zakir², Ahsan Ali¹, Rabia Nayab¹, Amir Mehmood¹, Irfan Ullah khan¹

¹Rehman College of Dentistry, Peshawar, KP, Pakistan

²Senior Registrar, Peshawar dental college, Peshawar, KP, Pakistan

ABSTRACT

Objectives: To determine the diagnostic accuracy of cold test and electric Pulp testing for testing pulp vitality in single rooted teeth with irreversible pulpitis

Materials and Methods: This cross-sectional study validation study was carried out in the Operative dentistry department at Rehman College of Dentistry Peshawar, from January 2019 to June 2019. Non-probability consecutive sampling technique was used. Expected sensitivity was 0.945 and expected specificity was 0.925, keeping β -error (precision) 6% and α -error (confidence interval) 95%, sample size was calculated. Of total of 120 participants with the history of irreversible pulpitis were included in the study. Teeth were cleaned and ionic medium (toothpaste) was applied to the diseased tooth. An electric pulp tester (EPT) and refrigerant spray (cold test) was used to apply at the mid of facial surface of teeth. Positive response to the electrical stimulus was recorded as 'vital' while absence of response showed that tooth is 'non-vital'. The sensitivity, specificity, positive predictive value negative predictive value and the overall accuracy for both cold test and EPT was calculated.

Results: On clinical observation 81(45%) teeth were non-vital and 99(55%) were vital. The Sensitivity and specificity of EPT was 94.95% and 92.59% respectively and diagnostic accuracy of EPT was 93.89%. The diagnostic values of cold test were lesser than EPT. The Sensitivity and specificity of cold test was 77.78% and 75.31% respectively. And diagnostic accuracy of cold test was 76.67%.

Conclusion: The electric pulp test is more reliable than cold test in diagnosing pulp vitality. The cold test sensitivity was higher in males, but specificity was higher in females. Age has no association with the accuracy of EPT and cold test in diagnosis of pulp vitality.

Key words: Cold test, Electric pulp test, Pulp sensibility, Pulp Vitality

INTRODUCTION

Diagnosis is the key to successful treatment plan, and in endodontics, accurate assessment of dental pulp health is essential. Correct diagnosis can be ascertained through a thorough clinical history, clinical and radiographic examination, and clinical diagnostic tests¹. Pulp tests can be classified into

pulp vitality and sensibility tests. Pulp sensibility includes thermal and electrical stimulation². Pulp vitality tests are expensive, technique and takes more time³. Irreversible pulpitis is the condition in which pulp is irreversibly damaged. Prevalence of irreversible pulpitis is 60.7%, 68.2% and 43% in molars, premolars and anterior teeth respectively.⁴

Commonly used dental pulp sensibility tests are cold tests and electric pulp tester⁵. CO₂ spray, ethyl chloride spray and Endo-Ice (1,1,1,2 tetra-flourethane) can be used for cold testing. Hot tests include heated gutta-percha and dry heat produced by prophylactic rubber cups⁶. Sensitivity refers to ability of test to

Correspondence:

Mashal Zeb Jan

Operative Department, Rehman College of Dentistry, Peshawar

Cell: +923339569111

Email: mashalzebjan123@gmail.com

identify teeth that are diseased (necrotic pulp). Specificity refers to ability of test to identify teeth without disease (vital pulp). The positive predictive value is the probability that a positive test result (a tooth without a sensitive response) represents a diseased tooth (necrotic pulp) and the negative predictive value is the probability that a tooth with negative test result (a tooth with a sensitive response) is free from disease (vital pulp)^{7,8}.

In a study by Rebecca et al⁹ the results showed that the combination of both EPT and cold test provided accurate results than using one method alone.

The rationale of our study is to determine the diagnostic accuracy of pulp sensibility tests, whether thermal, electrical stimulation or combination of both should be used in clinical setting for determination of pulp vitality. In the present study, pulpal bleeding during pulpectomy procedure was taken as a control. It will help clinicians to select the type of pulp sensibility test to determine the dental pulp status and make an accurate diagnosis as correct diagnosis is the key to successful treatment plan.

MATERIALS AND METHODS

This cross-sectional validation study was carried out in the Operative dentistry department at Rehman College of Dentistry Peshawar, from January 2019 to June 2019 after the ethical committee permission (EC ref No: RCD-18-09-102). Non-probability consecutive sampling technique was used. Expected sensitivity was 0.945 and expected specificity was 0.925, keeping β-error (precision) 6% and α-error (confidence interval) 95%, sample size was calculated by using following formulas;

$N = Z^2 \times [(S_n (1-S_n))] / E^2$	=	$(1.96)^2 \times (0.94 \times 0.06) / (0.05)^2 = 90$
$N = Z^2 \times [(S_p (1-S_p))] / E^2$	=	$(1.96)^2 \times (0.92 \times 0.08) / (0.05)^2 = 113$

Thus the calculated sample size was 120 cases. A total of 120 participants from both gender, age range of 15 to 45 years, single rooted carious teeth, with history of irreversible pulpitis, systemically healthy patients and no drugs history for 3 months were included in the study. The exclusion criteria were crown restoration, recent trauma, regressed pulp chambers, severe root canal obliteration and presence of periapical radiolucency.

After taking the informed consent, a single operator took the clinical history, perform examination and carried out the radiographs of the diseased teeth. Diagnostic tests were administered by the researcher who was be blinded to the patient’s history and radiograph. The participants were asked to tell the moment cold or tingling is felt during tests. Tooth isolation was carried out. First, the refrigerant spray was sprayed on the cotton pellet, placed on the the diseased tooth for approximately 15 seconds. Response to the cold stimulus was recorded as ‘vital’ while absence of response showed that tooth is ‘non-vital.’

After 5 minutes, a conducive agent (toothpaste) application was done on the diseased tooth. An electric pulp tester tip was put at the facial surface of control tooth. The response of the participant to electrical stimulation and reading on EPT was noticed. Response to the electrical stimulus was recorded as ‘vital’ while absence of response showed that tooth is ‘non-vital.’

The actual pulp health (vital/necrotic) was determined on entry into pulp chamber. The presence bleeding showed that pulp is vital while absence of bleeding depicted pulpal necrosis. Root canal treatment of necrotic tooth was carried out. Only researcher carried out this procedure to avoid inter-examiner variability.

Data were analysed using SPSS version 22. Mean and standard deviation was calculated for numerical variable like age. Frequency and percentages were calculated for categorical variables like gender, finding on cold and electric pulp tester (EPT). The sensitivity, specificity, positive predictive value, negative predictive value and the overall accuracy for both cold test and EPT was calculated using 2x2 table.

95% CI and diagnostic parameters (sensitivity, specificity etc) were calculated in Medcalc calculator online.

Gold standard

	True positives (a)	False positives (b)
Cold test/+ EPT	False negatives (c)	True negative (d)

RESULT

A total of 120 participants from both genders were selected. The mean age of participants was 30 years. The males (n=101, 56.1%) were more than females (n=79, 43.9%). On clinical observation 81(45%) teeth were non-vital and 99(55%) were vital. (table 1). The most common age group was 26 to 35 years (n=74, 41.11%) followed by 36 to 45 years (n=58, 32.22%).

Table 2 shows overall diagnostic accuracy statistics of EPT using bleeding on inspection as gold standard. The 95% CI of all statistics were statistically significant. The sensitivity and specificity of EPT was 94.95% and 92.59% respectively and diagnostic accuracy of EPT was 93.89%.

Table 3 shows overall diagnostic accuracy statistics of cold test using bleeding on inspection as gold standard. 95% CI of all statistics were statistically significant. The Sensitivity and specificity of cold test was 77.78% and 75.31% respectively. And diagnostic accuracy of cold test was 76.67%. Rest of details is given in table 9.

DISCUSSION

The cold test is a primary pulp sensitivity test and is important to make endodontic diagnosis.¹⁰ Our findings showed that overall the diagnostic accuracy of EPT was very good i.e. 90%. The Sensitivity

and specificity of EPT was 94.95% and 92.59% respectively. And diagnostic accuracy of cold test was 93.89%. Among various groups the results for diagnostic accuracy of EPT were not much different. In males the diagnostic accuracy of EPT was higher than females but in females the most of diagnostic values were higher than 90%. The diagnostic values of cold test were lesser than EPT. The Sensitivity and specificity of cold test was 77.78% and 75.31% respectively. And diagnostic accuracy of cold test was 76.67%.

In our study we used gold standard was opening the pulp chamber and visual inspection of pulpal condition (bleeding). Bleeding on entry into pulp chamber shows that pulp is vital while the absence of bleeding depicts that pulp is necrotic.^{11,12} Similar gold standard was used in previous study.¹³

The results of the current study showed that the Sensitivity and specificity of EPT was 94.95% and 92.59% respectively. And diagnostic accuracy of cold test was 93.89%. These show that EPT in our sample was sensitive and specific. A previous study by Weisleder et al.⁹ showed that Sensitivity and specificity of EPT was 92% and 79% respectively. These results were sensitive but not specific. This difference in results can be due to experience of clinician, vitality of teeth and patients understanding.

In a study by Jesperen et al.⁶ the performance of dental pulp sensibility testing electric pulp tester was evaluated. The sensitivity, specificity and diagnostic accuracy values for each test were calculated by comparing the test results with direct visual inspection. The EPT results showed accuracy; 0.75 sensitivity, and 0.84 specificity. Our study has higher

Table 1: Frequency of tooth vitality and gender

		n (%)
Tooth	Non-vital	45.0
	Vital	55.0
Gender	Male	56.1
	Female	43.9

Table 2: Overall diagnostic accuracy statistics of EPT

Statistic	Value	95% CI
Sensitivity (%)	94.95	88.61 to 98.34
Specificity (%)	92.59	84.57 to 97.23
Positive Likelihood Ratio	12.82	5.93 to 27.72
Negative Likelihood Ratio	0.05	0.02 to 0.13
Positive Predictive Value (%)	94.00	87.87 to 97.13
Negative Predictive Value (%)	93.75	86.43 to 97.25
D. Accuracy (%)	93.89	89.33 to 96.91

Table 3: Overall diagnostic accuracy statistics of cold test

Statistic	Value	95% CI
Sensitivity (%)	77.78%	68.31% to 85.52%
Specificity (%)	75.31%	64.47% to 84.22%
Positive Likelihood Ratio	3.15	2.12 to 4.67
Negative Likelihood Ratio	0.3	0.20 to 0.44
Positive Predictive Value (%)	79.38%	72.18% to 85.10%
Negative Predictive Value (%)	73.49%	65.27% to 80.36%
D. Accuracy (%)	76.67%	69.80% to 82.64%

diagnostic values than Jesperen et al⁶. This difference in results can be due to ethnic, genetics, experience of clinician, vitality of teeth and patients understanding.

Our findings showed that the Sensitivity and specificity of cold test was 77.78% and 75.31% respectively. And diagnostic accuracy of cold test was 76.67%. This showed that diagnostic accuracy of cold test was less than EPT in our study. Previous study showed the sensitivity of cold test was less than EPT. But the specificity was higher.¹⁴

Another study showed that sensitivity of cold test was 87% and specificity was 84%. The adjusted accuracy of cold test was 84%.¹⁵ These values are little higher than our study. This shows variability of results across the various populations.

Our results showed that among various age groups the diagnostic values of EPT and cold test were not much different. Similar results were shown in previous study.¹¹ In the present study, accuracy of pulpal was higher in males than females while previous study¹⁵ showed these tests were more accurate in females. The difference in results can be due to ethnic and genetic variations.

The sensibility tests applied in the present study are subjective and recorded by response of the patients. Since the psychogenic part of nociception and response to stimulus plays a critical role in the results of subjective tests, it is suggested to use objective vitality tests such as laser Doppler flowmetry and pulse oximetry for better assessment of the changes in the pulpal neural network. Another limitation was variation in comprehension and understanding level of the patients. Despite the limitations, the study is important as a first step for conducting future experiments.

CONCLUSION

The electric pulp test is more reliable than cold test in diagnosing pulp vitality. The accuracy of EPT is more in males than females. The cold test sensitivity was higher in males, but specificity was higher in females. Age has no major effect on accuracy of EPT and cold test in diagnosis of pulp vitality.

REFERENCES

1. Alghaithy R, Qualtrough A. Pulp sensibility and vitality tests for diagnosing pulpal health in permanent teeth: a critical review. *Int Endod J* 2017;50(2):135-42.

2. Levin LG. Pulp and periradicular testing. *Pediatr Dent* 2013;35(2):113-9.
3. Farid H, Khan FR, Pasha L, Shinwari MS. Are pulp sensibility tests still sensible? *J Ayub Med Coll Abbott* 2015;27(4):874-7.
4. Yazdani S, Jadidfard M-P, Tahani B, Kazemian A, Dianat O, Marvasti LA. Health technology assessment of CEM pulpotomy in permanent molars with irreversible pulpitis. *Iran Endod J* 2014;9(1):23-9.
5. Mejare I, Axelsson S, Davidson T, Frisk F, Hakeberg M, Kvist T, et al. Diagnosis of the condition of the dental pulp: a systematic review. *Int Endod J* 2012;45(7):597-613.
6. Jespersen JJ, Hellstein J, Williamson A, Johnson WT, Qian F. Evaluation of dental pulp sensibility tests in a clinical setting. *J Endod* 2014;40(3):351-4.
7. Villa-Chávez CE, Patiño-Marín N, Loyola-Rodríguez JP, Zavala-Alonso NV, Martínez-Castañón GA, Medina-Solís CE. Predictive values of thermal and electrical dental pulp tests: a clinical study. *J Endod* 2013;39(8):965-9.
8. Gopikrishna V, Tinagupta K, Kandaswamy D. Evaluation of efficacy of a new custom-made pulse oximeter dental probe in comparison with the electrical and thermal tests for assessing pulp vitality. *J Endod* 2007;33(4):411-4.
9. Weisleder R, Yamauchi S, Caplan DJ, Trope M, Teixeira FB. The validity of pulp testing: a clinical study. *J Am Dent Assoc* 2009;140(8):1013-7.
10. Cisneros-Cabello R, Segura-Egea JJ. Relationship of patient complaints and signs to histopathologic diagnosis of pulpal condition. *Austr Endod J* 2005;31(1):24-7.
11. Castillo-Silva BE, Alegría-Torres JA, Martínez-Castañón GA, Medina-Solís CE, Zavala-Alonso NV, Niño-Martínez N, et al. Diagnostic accuracy of three placement sites for the cold test in subjects amongst different age groups. *BMC Oral Health* 2019;19(1):189.
12. Dastmalchi N, Jafarzadeh H, Moradi S. Comparison of the efficacy of a custom-made pulse oximeter probe with digital electric pulp tester, cold spray, and rubber cup for assessing pulp vitality. *J Endod* 2012;38(9):1182-6.
13. Balevi B. Cold pulp testing is the simplest and most accurate of all dental pulp sensibility tests. *Evid Baed Dent* 2019;20(1):22-3.
14. Stoops LC, Scott Jr D. Measurement of tooth temperature as a means of determining pulp vitality. *J Endod* 1976;2(5):141-5.
15. Ramsay D, Artun J, Martinen S. Reliability of pulpal blood-flow measurements utilizing laser Doppler flowmetry. *J Dent Res* 1991;70(11):1427-30.