

Electric pulp test response threshold in anterior teeth of patients with and without a history of COVID-19: an analytical cross-sectional study

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ABSTRACT

Objective: To compare the electric pulp test (EPT) response threshold in anterior teeth of adults with and without a history of COVID-19. **Materials and methods:** An observational, cross-sectional, analytical study conducted in 2024. Eighty-nine adults were evaluated (48 women and 41 men): 49 with no history of COVID-19 and 40 with a confirmed diagnosis recorded in medical record. No uniform interval was established between infection and clinical evaluation. A standardized EPT protocol based on prior recommendations for pulp sensitivity testing was applied to the upper and lower incisors and canines: electrode placement on the middle third of the buccal surface, use of a conductive medium, isolation with a dry field, and two measurements per tooth to obtain a mean. The primary variable was the individual mean EPT response threshold, and the exposure variable was history of COVID-19 (yes/no). Descriptive statistics, Student's t-test for independent samples, and chi-square tests were used, with a 95% CI. The primary analysis accounted for tooth-within-subject nesting using a linear mixed model (random intercept per subject; fixed effects for COVID-19, tooth type, age, and sex). **Results:** The response threshold showed a mean of 25.29 s (SD = 23.42) in the group without COVID-19 and 42.29 s (SD = 28.58) in the group with COVID-19, representing a mean difference of 17 s (95% CI [5.80–28.20]; $p = 0.003$). Descriptively, the group with a history of infection showed higher response thresholds across all anterior teeth evaluated. In the adjusted linear mixed model, history of COVID-19 remained significantly associated with a higher EPT response threshold (adjusted $\beta = 15.9$ s; $p = 0.005$). **Conclusions:** In this clinical sample, having had COVID-19 was associated with an increase in the EPT response threshold in anterior teeth. These findings should be considered preliminary and require confirmation in longitudinal studies incorporating variables such as severity, time since infection, and potential confounders.

Keywords: COVID-19; dental pulp test; dental sensitivity; incisors; canines.

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INTRODUCTION

Infection with SARS-CoV-2, the virus that causes COVID-19, affects not only the respiratory system but also several organ systems, including the central and peripheral nervous systems, through multiple pathophysiological mechanisms (1,2). Preclinical and clinical research has shown that coronaviruses have an affinity for the central nervous system and can enter it through the olfactory or trigeminal pathways via diffusion and retrograde axonal transport (3,4). Studies have detected viral RNA and neuronal damage in the brains of infected patients who developed neurological symptoms such as loss of taste and smell, cranial neuropathies, and generalized sensory impairment, including paresthesia, orofacial pain, and headache (4–7).

Dental pulp is living tissue primarily innervated by branches of the trigeminal nerve and is sensitive to physiological and nociceptive stimuli; therefore, assessment of its vitality is an essential component of dental evaluation (8,9). Among the diagnostic methods used to assess the neural response of the dental pulp is the Electric Pulp Test (EPT), which measures sensibility through controlled electrical stimulation and quantification of the response threshold (10). This value has gained particular relevance in the post-COVID-19 era because of the sensory changes observed in the oral cavity and the possible impairment of nerve fibers following viral infection (2,11).

The COVID-19 pandemic represented a major public health problem, not only because of the morbidity and mortality it caused but also because of the persistent neurological and sensory sequelae affecting a considerable proportion of recovered patients. These sequelae impair quality of life and complicate clinical management across various specialties, including dentistry (1,2,7,12). In particular, sensory symptoms such as oral dysesthesia, taste disturbances, orofacial pain, and cranial neuropathies have been reported in up to one-third of cases, underscoring the need to adopt more sensitive and specific diagnostic approaches in the post-COVID-19 context (1,7,12).

However, evidence regarding alterations in the neural response of the dental pulp following COVID-19 infection remains limited, and no standardized diagnostic criteria are available for identifying viral sensory dysfunction in dentistry. This represents a significant gap in both clinical practice and research (8,9,13–15).

In this scenario, given the clinical variability and current diagnostic challenges in determining COVID-19-related pulpal dysfunction, it is essential to strengthen neuro-dental assessment and differential diagnosis. This may facilitate the selection of the most appropriate conservative or surgical treatment for patients with a history of SARS-CoV-2 infection. Therefore, this study aimed to

compare the response threshold to EPT in the anterior teeth of adults with and without a history of COVID-19.

MATERIALS AND METHODS

An observational, analytical, cross-sectional study was conducted in 2024 at the School of Dentistry of Universidad Nacional Federico Villarreal (UNFV) and at Hospital Santa Rosa (Lima, Peru), with authorization from both institutions.

The accessible population consisted of adult patients aged 19 to 63 years who were treated in the clinical training programs in periodontics, operative dentistry, and general dentistry, without assuming an infinite population. The sample size was calculated using the formula for comparing independent means, considering a prespecified clinically significant difference based on a pilot study, an expected standard deviation, a 95% confidence level ($\alpha = 0.05$), and 80% statistical power. A total of 89 participants were included, comprising 49 without a history of COVID-19 and 40 with a confirmed diagnosis, selected through consecutive nonprobability sampling. For operational purposes, a history of infection was considered present when a previously confirmed diagnosis was documented in the patient's comprehensive medical record. Because no uniform interval was established between the date of infection and the dental evaluation, this variable was not incorporated as a temporal stratum in the analysis. Participant selection was based on the following criteria:

- *Inclusion criteria:* adult patients aged 19–63 who were treated in the aforementioned clinical training programs, with or without a confirmed history of COVID-19 infection.
- *Exclusion criteria:* patients with pacemakers or cardiac valves; patients with preexisting neurological disease or documented sensory disturbances, patients who refused to participate in the study, and patients with extensive restorations in the anterior teeth.

For the purposes of this study, extensive restorations were defined as those involving the middle third of the facial surface, the incisal edge, or more than one-third of the clinical crown, due to their potential interference with electrode placement and uniform conduction of the electrical stimulus.

The primary unit of analysis was the participant. The outcome variable was the individual mean EPT response threshold, calculated from the anterior teeth evaluated. As a secondary descriptive analysis, the response threshold was recorded individually for each tooth (teeth 13, 12, 11, 21, 22, 23, 33, 32, 31, 41, 42, and 43). In addition, the study variables were categorized as follows:

history of COVID-19 (qualitative dichotomous variable; nominal scale: yes/no), response threshold expressed as EPT latency in seconds (continuous quantitative variable; ratio scale), age in years (continuous quantitative variable; ratio scale), and biological sex (qualitative dichotomous variable; nominal scale: female/male).

Sociodemographic and clinical data were extracted from the comprehensive medical records kept by the School of Dentistry. A standardized data collection form with a segmented dental chart was used to record the pulpal sensory threshold, and the EPT results for the selected teeth were documented accordingly. The procedure was based on previous recommendations for pulp sensibility testing and was applied uniformly throughout the study population; therefore, it was considered appropriate for the clinical evaluation of the participants (8,16).

The procedure was standardized by positioning the patient in a semireclined position (45°), in a relaxed state and free of metallic objects. The test was performed in a dry operative field. For this purpose, the maxillary and mandibular anterior regions were isolated with sterile gauze after placement of a mouth retractor. Conductive gel (Ecogel®, Sonogel; Germany) was applied, and the negative electrode (stainless-steel hook) was connected to the mandibular buccal mucosa. A digital pulp tester (Digitest®, Parkell; USA), previously calibrated in fixed-rate mode, was then used.

Before the measurement began, the patient was instructed to raise a hand when she first perceived the electrical stimulus. The stimulating electrode was placed on the middle third of the facial surface of each tooth. For each tooth, two measurements were obtained at a 5-minute interval, and the mean of the two measurements was recorded (Figures 1 and 2). The device recorded and displayed the response threshold value, expressed as latency in seconds. All data were coded in Microsoft Excel® (Microsoft 365; USA) and statistically analyzed using SPSS v. 26.0® (IBM; USA). Both software programs were licensed by UNFV.



Figure 1. Materials and equipment used for the Electric Pulp Test (EPT) in anterior teeth.



Figure 2. Clinical application of the Electric Pulp Test (EPT) in anterior teeth using a digital pulp tester.

Regarding the study limitations, no specific assessment was performed for chronic medication use with potential neurological or analgesic effects, systemic comorbidities (such as diabetes or autoimmune diseases), tobacco or alcohol use, or a history of dental trauma, beyond the routine clinical assessment and exclusion of documented neurological disorders and sensory disturbances. Therefore, these variables were considered potential residual confounders. In addition, the examiner was not blinded to the participant's history of COVID-19 during EPT administration, which is acknowledged as a methodological limitation of the study.

Data analysis included descriptive statistics (frequencies, percentages, means, and standard deviations). Age and the individual mean EPT response thresholds were compared between groups using an independent-samples Student's t-test, whereas sex distribution was compared using the chi-square test. To estimate the overall effect, the mean difference and its corresponding 95% confidence interval were calculated. Comparisons by tooth are presented descriptively to avoid interpreting observations nested within the same participant as independent.

Since each participant provided measurements from several anterior teeth, the primary analysis of the EPT response threshold was performed using a linear mixed-effects model. This model accounted for the tooth-within-subject nesting structure, with a random intercept for each participant and fixed effects for history of COVID-19, tooth type, age, and sex. A compound symmetry covariance structure was assumed to model the within-participant correlation among repeated measurements. Model assumptions were assessed through graphical inspection of residuals to evaluate normality and homoscedasticity. Outliers were explored; however, no observations were excluded because no recording or measurement errors were identified. At the same time, there were no missing data. A significance level of 5% ($p < 0.05$) was established.

The study complied with current national and international ethical standards for the protection of personal and sensitive data, in accordance with Law No. 29733 (Personal Data Protection Law and its Regulations). Written informed consent was obtained from all participants before any clinical procedures were performed. The study protocol was approved by the Research Ethics Committee of Hospital Santa Rosa (CEI-HSR) through Resolution No. 28-2024-MINSA-HSR-DG and Certificate No. 017-2024-CEI-HSR.

RESULTS

Sex distribution included 48 women (54%) and 41 men (46%). Mean age did not differ between the groups

(without COVID-19: 36.5 ± 9.2 years; with COVID-19: 35.7 ± 8.8 years; p = 0.72, independent-samples t-test). Sex distribution showed no statistically significant differences between the two groups (p = 0.39, chi-square test).

The overall comparison of the individual mean EPT response threshold is presented in Table 1. The group with a history of COVID-19 had a mean response threshold of 42.29 s (SD = 28.58), whereas the group without a history of COVID-19 had a mean response threshold of 25.29 s (SD = 23.42). The mean difference between the groups was 17 s (95% CI [5.80–28.20]; p = 0.003).

Table 1. Overall comparison of the individual mean response threshold to the Electric Pulp Test (EPT) according to history of COVID-19.

Group	n	Mean	SD	Mean difference	95% CI	p-value*
Without COVID-19	49	25.29	23.42	Reference	-	
With COVID-19	40	42.29	28.58	17.00	5.80-28.20	0,003

*Comparison between groups using Student’s t test for independent samples, with the individual mean EPT response threshold per participant as the outcome. SD: standard deviation.

The descriptive values of the EPT response threshold by anterior tooth type are summarized in Table 2. In all the teeth evaluated, the mean values were higher in the

group with a history of COVID-19 than in the control group, with no reversal of this trend observed in any of the teeth evaluated.

Table 2. Descriptive comparison of the response threshold to the Electric Pulp Test (EPT) by anterior tooth type and history of COVID-19.

Tooth*	Without COVID-19		With COVID-19		Absolute difference (with/without)	p-value
	$\bar{x}$	SD	$\bar{x}$	SD		
13	38.50	28.94	65.40	22.40	26.90	<0.001
12	15.80	17.54	27.89	27.55	12.09	0.014
11	20.37	23.07	36.89	30.89	16.52	0.005
21	17.31	21.51	32.56	30.95	15.25	0.008
22	20.70	22.68	32.37	28.76	11.67	0.035
23	45.87	30.14	50.74	30.21	4.87	0.451
33	38.37	30.29	54.26	29.67	15.89	0.015
32	18.31	17.29	35.39	30.21	17.08	0.001
31	15.43	21.05	33.44	30.70	18.01	0.002
41	14.37	17.94	30.67	27.30	16.30	0.001
42	20.06	19.55	40.28	28.97	20.22	<0.001
43	38.39	31.09	67.58	25.34	29.19	<0.001
Total	25.29	23.42	42.29	28.58	17.00	0.003

* p-values were obtained using Student’s t-test for independent samples. Comparisons by individual tooth are presented as an exploratory analysis; the primary inferential analysis accounted for tooth-within-subject nesting using a linear mixed-effects model. SD: standard deviation.

Figures 3 and 4 show the distribution and dispersion of the EPT response threshold according to history of COVID-19. In both graphical representations, the values were shifted toward higher thresholds in the group with a history of infection. In the linear mixed-effects

model—which accounts for tooth-within-subject nesting and is adjusted for tooth type, age, and sex—a history of COVID-19 was significantly associated with an increased EPT response threshold.

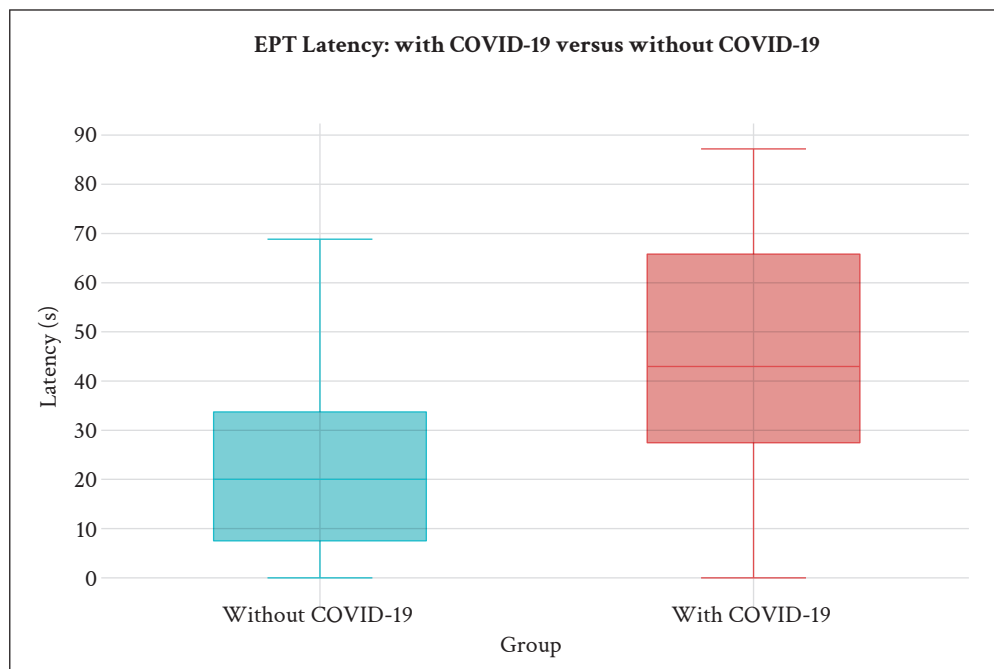


Figure 3. Box plot of the response threshold to the Electric Pulp Test (EPT) in subjects with and without a history of COVID-19.

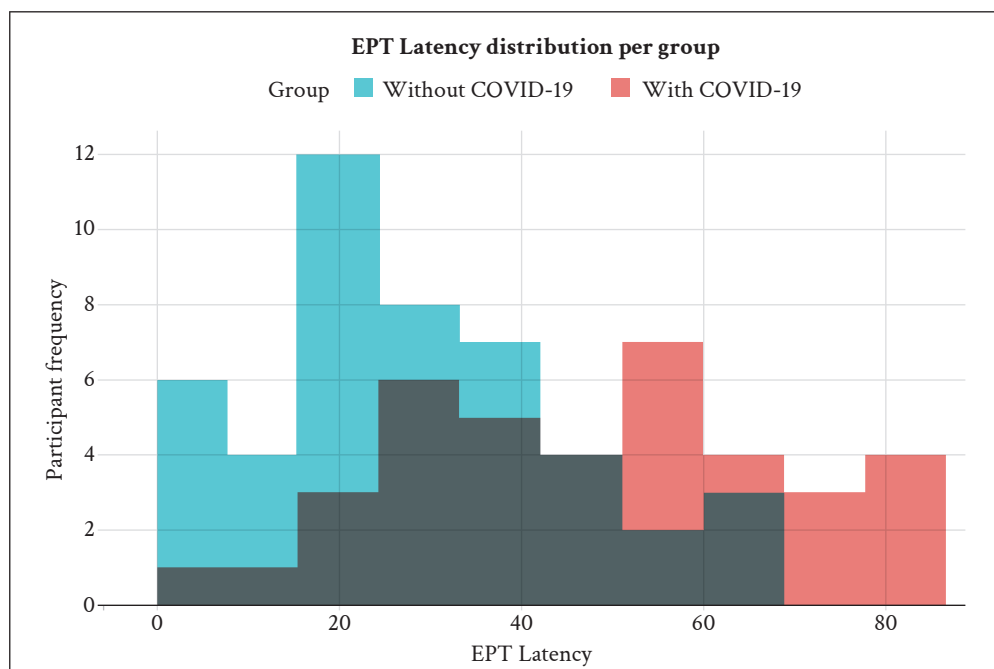


Figure 4. Comparative histogram of the response threshold to the Electric Pulp Test (EPT) according to history of COVID-19.

On average, participants with a history of COVID-19 had a response threshold approximately 16 seconds higher than those without such a history (adjusted $\beta = 15.9$ s; 95% CI [4.8–27.0]; $p = 0.005$), as shown in Figure 5. Tooth type showed variation in response times, with a tendency toward higher thresholds in canines

than in incisors, whereas age and sex were not significantly associated with the outcome ($p > 0.05$). Graphical assessment of the residuals showed no relevant deviations from normality or evidence of heteroscedasticity, and no influential outliers were identified that substantially altered the estimate of the primary effect.

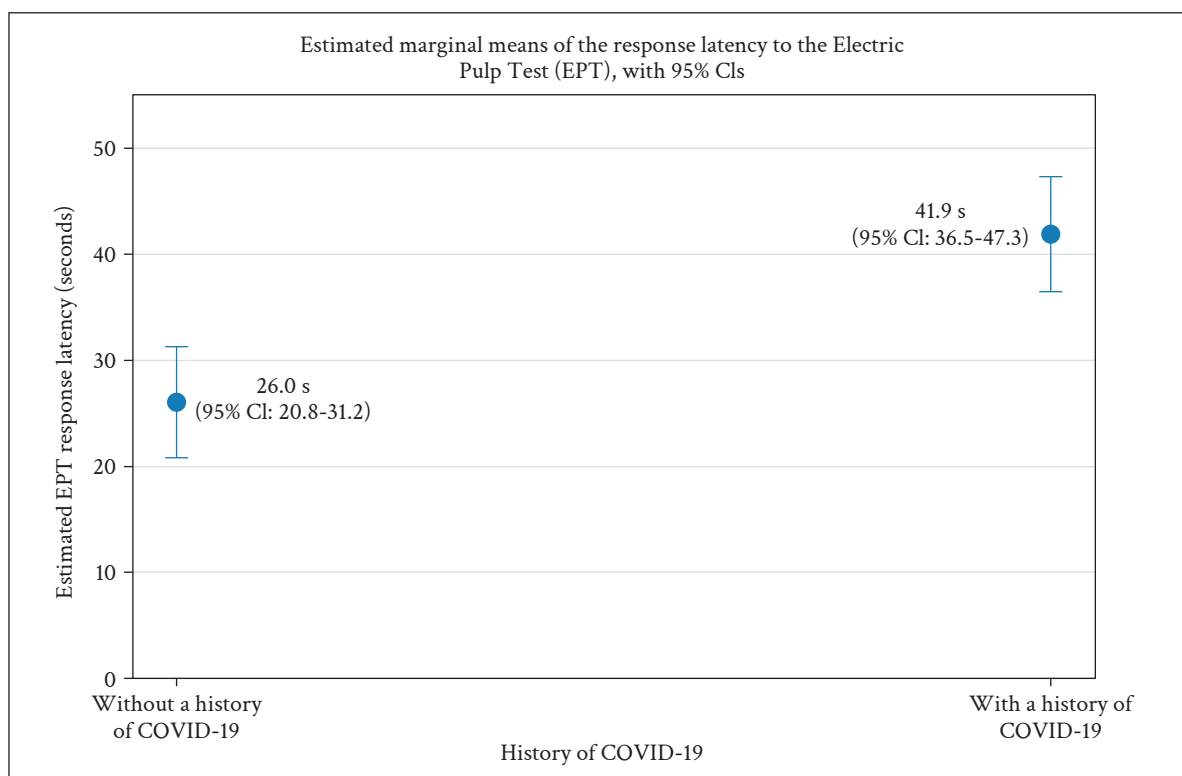


Figure 5. Estimated marginal means of the response threshold to the Electric Pulp Test (EPT) according to history of COVID-19, adjusted for tooth type, age, and sex, with 95% confidence intervals.

DISCUSSION

Adult patients with a history of COVID-19 had a higher EPT response threshold in anterior teeth than those without such a history. Due to the cross-sectional nature of the study design, this finding should be interpreted as a clinical association rather than as evidence of a proven causal relationship.

These findings are consistent with recent reports of oral and peripheral sensory alterations following COVID-19, which have been attributed to viral neurotropism, afferent fiber dysfunction, and persistent neuroinflammatory processes (7,11,12,15). From a pathophysiological perspective, it is reasonable to distinguish between two non-mutually exclusive scenarios: more immediate axonal injury, which could alter nerve conduction at an early stage and increase the response threshold, and chronic or subclinical inflammation with a more prolonged course, which could perpetuate sensory alterations even after the acute phase. In the dental pulp, both mechanisms could result in delayed responses to electrical stimulation and make diagnostic interpretation more challenging in the post-COVID-19 context (8,16).

The clinical relevance of this study lies in the fact that, although EPT is an accessible and routinely used test, its results should not be interpreted in isolation in patients with a history of SARS-CoV-2 infection. In actual clinical practice, diagnostic assessment should integrate

a correlation with thermal testing, clinical findings, pain history, radiographic examination, and, when indicated, complementary imaging methods or clinical follow-up to avoid irreversible treatment decisions based on a single sensibility test (8,13,14,16).

The strengths of this study include the clinical relevance of the research question, the consistent application of a standardized protocol, and the analysis of the primary outcome at the participant level. However, several limitations should be acknowledged, including the lack of examiner blinding; the absence of specific control for neurological or analgesic medications, systemic comorbidities, smoking, alcohol consumption, and dental trauma; the lack of stratification according to viral variant, vaccination status, disease severity, or time elapsed since infection; and the inability to draw causal inferences because of the cross-sectional design. Additionally, the sample size and its clinical and institutional setting limit the generalizability of the results to other populations.

Overall, the findings suggest that a history of COVID-19 may be associated with alterations in pulpal sensibility that can be detected using the EPT. This observation supports the need for longitudinal and analytical studies that incorporate post-infection timing, clinical severity, vaccination status, and other potential confounders to clarify the duration, magnitude, and reversibility of these changes in dental practice.

CONCLUSIONS

In the clinical sample, a history of COVID-19 infection was associated with a higher EPT response threshold in the anterior teeth of adults. This association remained significant in the linear mixed-effects model adjusted for tooth type, age, and sex, supporting the consistency of the observed finding.

Given the cross-sectional design, the absence of blinding, and the limited control of potential confounders, the results should be interpreted as preliminary. In clinical practice, EPT should not be used in isolation in patients with a history of COVID-19 but should be complemented by other sensibility tests, a comprehensive clinical evaluation, and imaging when appropriate. Prospective studies are needed to assess disease severity, time elapsed since infection, vaccination status, and other clinically relevant variables.

Conflict of interest:

The authors declare no conflict of interest.

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RLS: conceptualization, methodology, research, formal analysis, validation, writing of original draft, writing - review & editing. **JMG:** conceptualization, methodology, formal analysis, supervision, writing - review & editing. **KCM, MCM:** research, data curation, formal analysis, writing of original draft, writing - review & editing. **RVS, JMC:** formal analysis, visualization, writing - review & editing.

Statement on the use of artificial intelligence:

Gemini and ChatGPT were used for basic grammar, spelling, and punctuation correction, as well as for writing and synthesis support. The authors reviewed and edited the resulting content and assume full responsibility for the integrity and accuracy of the manuscript.

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REFERENCES

1. Arriola LF, Palomino KR. [Neurological manifestations of COVID-19: A literature review]. *Neurolog Argent*. 2020;12(4):271-4. doi:[10.1016/j.neuarg.2020.07.005](https://doi.org/10.1016/j.neuarg.2020.07.005) Spanish.
2. Alarco R, Huarcaya-Victoria J. [Potential neuroinvasion pathways of SARS-CoV-2: a review of the current literature]. *Rev Neuropsiquiatr*. 2021;84(1):25-32. doi:[10.20453/rnp.v84i1.3935](https://doi.org/10.20453/rnp.v84i1.3935) Spanish.
3. Desforges M, Le Coupanec A, Dubeau P, et al. Human coronaviruses and other respiratory viruses: underestimated opportunistic pathogens of the central nervous system? *Viruses*. 2020;12(1):14. doi:[10.3390/v12010014](https://doi.org/10.3390/v12010014)
4. Netland J, Meyerholz DK, Moore S, et al. Severe acute respiratory syndrome coronavirus infection causes neuronal death in the absence of encephalitis in mice transgenic for human ACE2. *J Virol*. 2008;82(15):7264-75. doi:[10.1128/jvi.00737-08](https://doi.org/10.1128/jvi.00737-08)
5. Gu J, Gong E, Zhang B, et al. Multiple organ infection and the pathogenesis of SARS. *J Exp Med*. 2005;202(3):415-24. doi:[10.1084/jem.20050828](https://doi.org/10.1084/jem.20050828)
6. Bohmwald K, Gálvez NM, Ríos M, et al. Neurologic alterations due to respiratory virus infections. *Front Cell Neurosci*. 2018;12:386. doi:[10.3389/fncel.2018.00386](https://doi.org/10.3389/fncel.2018.00386)
7. Serafini RA, Frere JJ, Giosan IM, et al. SARS-CoV-2-induced sensory perturbations: a narrative review of clinical phenotypes, molecular pathologies, and possible interventions. *Brain Behav Immun Health*. 2025;45:100983. doi:[10.1016/j.bbih.2025.100983](https://doi.org/10.1016/j.bbih.2025.100983)
8. Chen E, Abbott PV. Dental pulp testing: a review. *Int J Dent*. 2009;2009:365785. doi:[10.1155/2009/365785](https://doi.org/10.1155/2009/365785)
9. Ono M. Advances in electric pulp testing using dental instrument. *J Dentistry*. 2025;15:721. doi:[10.35248/2329-9088.25.15.721](https://doi.org/10.35248/2329-9088.25.15.721)
10. Afkhami F, Ghabraei S, Hashemi N, et al. Evaluation of cold and electric pulp tests for assessing depth of anesthesia in patients with symptomatic irreversible pulpitis. *J Endod*. 2025;51(1):28-34. doi:[10.1016/j.joen.2024.10.013](https://doi.org/10.1016/j.joen.2024.10.013)
11. Eitner L, Maier C, Brinkmann F, et al. Somatosensory abnormalities after infection with SARS-CoV-2 – A prospective case-control study in children

- and adolescents. *Front Pediatr.* 2022;10:977827. doi:[10.3389/fped.2022.977827](https://doi.org/10.3389/fped.2022.977827)
12. Mao L, Jin H, Wang M, et al. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurol.* 2020;77(6):683-90. doi:[10.1001/jamaneurol.2020.1127](https://doi.org/10.1001/jamaneurol.2020.1127)
13. Ozal MA, Petrocco C. [Thermal pulp sensitivity testing in permanent teeth with pulpitis: diagnostic value and limitations]. *Rev Odontopediatr Latinoam.* 2024;14:e-235652 . doi:[10.47990/etpeqz19](https://doi.org/10.47990/etpeqz19) Spanish.
14. Donnermeyer D, Dammaschke T, Lipski M, et al. Effectiveness of diagnosing pulpitis: a systematic review. *Int Endod J.* 2023;56(S3):296-325. doi:[10.1111/iej.13762](https://doi.org/10.1111/iej.13762)
15. Jamil H, Noor M, Hollinger J, et al. Isolated trigeminal mononeuropathy: a possible COVID-19 sequelae. *Cureus.* 2024;16(9):e68522. doi:[10.7759/cureus.68522](https://doi.org/10.7759/cureus.68522)
16. Patro S, Meto A, Mohanty A, et al. Diagnostic accuracy of Pulp vitality tests and pulp sensibility tests for assessing pulpal health: a systematic review and meta-analysis. *Int J Environ Res Public Health.* 2022;19(15):9599. doi:[10.3390/ijerph19159599](https://doi.org/10.3390/ijerph19159599)