Original Article

Radiographic Study of Dental Pulp Calcifications in Patients With COVID-19

Hussein Haleem Jasim[1]*

[1]Department of Oral Diagnosis, College of Dentistry, University of Wasit, Iraq.
ORCID iD: https://orcid.org/0000-0002-9555-3462, Email: halmhanawi@uowasit.edu.iq

Abstract

Background: COVID-19 is an infectious disease produced by the SARS coronavirus 2, which has led to significant disruption of healthcare systems worldwide. Originally identified as a severe respiratory illness. COVID-19 infection has been documented to lead to many health issues, including those related to dental health. Emerging evidence indicates that the virus can lead to symptoms in the oral cavity, such as xerostomia, ageusia, and mucosal lesions. Furthermore, prolonged COVID-19 infection has exhibited enduring oral manifestations, including gingivitis and temporomandibular joint abnormalities, indicating the importance of regular dental evaluations for convalescent individuals. **Aim of the Study:** To investigate the potential problems of COVID-19 infection in the development of pulp calcifications. **Materials and Methods:** A study population of 600 patients was enrolled, regardless of gender, aged between 18 and 50 years. The COVID-19 cohort (N=300) was included at least one year post-recovery. The control group (N=300) comprised individuals without a history of COVID-19 infection. Pulp calcifications were subsequently assessed using panoramic images. **Results:** The data analysis revealed that COVID-19 infection significantly influences the formation of pulp calcifications. The Chi-square statistic was 3.9, with a p-value of 0.045. The data indicated a substantial correlation between the severity of COVID-19 and forms of pulp calcification. Fisher's Exact Test p-value = 0.039. Statistically significant at p-value < 0.05. The findings indicated a higher prevalence of pulp calcifications in persons with COVID-19, around 5.0%, compared to 2.0% in the control group. A detailed analysis of the COVID-19 category revealed that the maxillary first molar was the most frequently affected, with an incidence rate of approximately 2.6%. The subsequent specimen was the mandibular first molar, recorded at approximately 1.9%. The maxillary first premolar was observed seldom, at a rate of 0.3%. Variations may arise from localised variables or systemic responses that are not entirely considered. **Conclusion:** The study demonstrated a strong correlation with COVID-19 and heightened pulp calcifications in comparison to unaffected individuals.

Keywords: Pulp Calcification, Pulp Stone, COVID-19, SARS-CoV-2, Infection, Endodontic Treatment Challenges.

Introduction

"Coronavirus disease of 2019 (COVID-19)" is a transmissible disease recognized by severe acute respiratory syndrome.[1] The furthermost recent universal pandemic of coronavirus infection is COVID-19 that arises from SARS-CoV-2.[2] The coronavirus family includes hundreds of different viruses; only six conditions (MERS-CoV, 229E, OC43, NL63, HKU1 and SARS-CoV) are confirmed to cause respiratory infections in individuals, changing in intensity from mild to severe. "SARS-CoV" was reported in November 2002. The Middle East respiratory syndrome, or what is called "MERS-CoV", was reported in September 2012. This virus developed from animals and caused intense respiratory disease with a high mortality rate. Later, a new severe acute respiratory syndrome, SARS-CoV-2 or coronavirus 2, appeared, leading to the infectious disease termed "coronavirus disease 2019 or COVID-19".[1] Still, no definitive answer has emerged regarding SARS-CoV-2 origin. The matter lingers, quietly unsettling, yet undeniably central—one of the more persistent, unresolved threads running through the broader pandemic narrative. Attention continues to gather around this issue, not only for understanding the present but also to better shape future prevention strategies. Some early investigations leaned toward bats. Not a surprise, perhaps, as these animals have often been noted as natural hosts for several coronaviruses—SARS-CoV, MERS-CoV, and others falling in similar families.[3]

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Address for Correspondence: Department of Oral Diagnosis, College of Dentistry, University of Wasit
Email: halmhanawi@uowasit.edu.iq

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SARS-CoV-2 mainly spreads via respiratory droplets, though aerosol transmission happens as well, and traces have been identified in stool samples.[4] Infection can stem from those showing symptoms or from individuals who don't display any. Secondary infection rates range between 0.5% and 5%, depending on setting. The virus shows surprising stability—lasting about 3 hours in aerosols, up to a full day on cardboard, and even extending to 72 hours when resting on plastic or stainless steel.[5] Average incubation tends to fall somewhere between 4 and 5 days, and almost all individuals—roughly 97.5%—develop symptoms by day 11.5 post-exposure.[6] Initial data indicates that fever (88%) and dry cough (67.7%) emerge as the most prevalent signs, similar to other viral illnesses. Meanwhile, runny nose (4.8%) and gastrointestinal complaints—such as diarrhea (4% to 14%) or nausea and vomiting (5%)—seem less commonly reported.[4]

Fever tends to show up a lot when illness hits. In one sizable Chinese study, it was noted in 44% of individuals right at admission, though that figure climbed to 88% after they were admitted.[6] A dry cough appeared in something like 65–70% of cases. Over in Europe, sensory changes were frequent—anosmia or hyposmia affected about 85%, while taste loss reached around 88%.[7] Appetite loss wasn't uncommon either. Muscle aches and shortness of breath were both present in nearly 30% of patients.[8] A review combining data from 60 different studies, totaling 4243 cases, pointed to gastrointestinal symptoms in about 17.6% (95% CI: 12.3–24.5%). How things progress clinically seems to vary a lot. Wang and colleagues found that the time from the very first symptom to shortness of breath was typically five days, to hospital admission about seven, and ARDS around eight. Intensive care was needed mostly in those with ARDS (61%), irregular heartbeats (44%), or shock (30%). Those ending up in the ICU were older (median age 66) and more often dealt with other health problems, close to 72.2%.[8]

Different age groups experience the illness differently. Yet, outcomes grow more severe as age advances, particularly when chronic health issues are present. Reports gathered from both China and the United States show a clear rise in hospital stays, critical care needs, and deaths among older adults. Data from China's Center for Disease Control and Prevention tied several conditions—heart disease, high blood pressure, diabetes, breathing disorders, and cancer—to negative outcomes.[9]

The term "case fatality rate" describes how many people, out of those confirmed to have the illness, die within a certain stretch of time. It gives some idea of how harmful the infection tends to be. In China's CDC report, the general case fatality rate came out at 2.3 percent. That was 1023 deaths, counted among 44,672 confirmed infections.[9] By contrast, the situation in Italy revealed a higher CFR—7.2%. A likely explanation lies in the demographic breakdown; in Italy, 37% of all cases were in individuals aged 70 and above, compared to just 11% in China. When looking beneath the age of 70, CFRs remained fairly comparable across both countries. Above that threshold, though, differences emerged. Among those aged 70–79 years, Italy's CFR reached 12.8% compared with 8% in China. For those aged 80 and up, Italy recorded 20.2%, whereas China had 14.8%.

Some of the suggested ways to reduce the spread include washing hands often using soap. Not just quickly, but carefully. When coughing, the mouth should be covered—best with the elbow or a cloth. Keeping a distance from others, about a meter or so, remains important in shared spaces. For anyone thinking they might be exposed, staying home and monitoring for about fourteen days is commonly advised.[10] As for diagnosis, the primary method relies on reverse transcription polymerase chain reaction—typically performed using either nasopharyngeal or throat swabs. Assessment may also involve evaluating symptoms alongside risk exposure, with chest CT scans often revealing pneumonia-like indications.[11]

Dentistry operates in one of the more exposed clinical environments. When protective equipment began falling short worldwide, pressure grew heavier. The pandemic didn't just disrupt—it overwhelmed. Keeping dental care reachable, across a landmass stretching 8.5 million square kilometers and serving more than 211 million people, became a near-impossible task. In this setting, Brazil holds a unique place—home to over half a million dental professionals, including more than 348,000 dentists,[12] One Italian study with 440 dentists[13] found that 68% feared catching the virus during procedures at the height of lockdowns. A broader survey across 30 nations, involving 669 practitioners,[14] revealed similar fears—87% felt at risk from patients or coworkers, while 90% experienced anxiety when treating coughing or suspected cases. Strikingly, a survey in Spain targeting the general public[15] painted a different picture—over 90% saw no real risk in attending dental visits and wouldn't cancel appointments. These differing attitudes likely stem from local pandemic conditions, such as infection and fatality trends, or perhaps from how national health systems responded overall. Shifts in clinical routines have also been noted. In Saudi Arabia, 287 dentists[16] took part in a survey showing that 65% of clinics had adopted new workflows, incorporating screenings, temperature checks, and distancing within waiting areas. In Italy, 57% of dentists[13] conducted phone triage before appointments, and about 80% implemented new PPE training—how to put it on, remove it, dispose of it properly.

The pandemic brought both financial weight and emotional wear from the dental field's side. Income from elective work vanished almost overnight. A lot of clinics—especially the smaller setups or ones running independently—found it hard to stay afloat. PPE wasn't just scarce—it was getting expensive, fast. At once, spending surged. No way around it. Ventilation systems had to be improved. Sterilization tools brought in. Filters—replaced, upgraded, replaced again. The expenses stacked quietly, then loudly. But cost was only part of it. The pressure pressed elsewhere, not just on balance sheets. The threat of the virus stayed close. PPE, sometimes not enough, frayed nerves. Worry hovered. Burnout didn't shout—it crept. Day by day. The team adapted. New ways of cleaning. New steps. Unfamiliar routines. All beneath a thick cloud of not-knowing. And that cloud—never really moved away. In response, dental spaces worldwide started raising the bar on infection control. Basic precautions no longer felt enough. N95 masks were brought in. So were full face shields. Gowns, resistant to fluids, became standard. Cleaning schedules grew more intense. Every surface, every room—wiped more often. Before even stepping inside, patients had to go through screening questions, temperature checks. Many had to wait outside until it was time. Inside, treatment areas were rearranged—ventilation improved where it could, spacing rethought to keep contact down.

A striking shift during the pandemic came with the broader reliance on rubber dams and strong suction systems, both used more routinely than before to help limit aerosol drift. While well known in restorative contexts, their role expanded, becoming standard in many treatment setups. Also noticed, a growing preference for pre-treatment mouth rinses containing agents like hydrogen peroxide or povidone-iodine, meant to cut down viral particles present in saliva. Although the exact strength of their effect on SARS-CoV-2 remains under review, this approach speaks volumes about the field's readiness to adapt, sometimes ahead of conclusive data. Another major pivot involved teledentistry. Of course, physical care can't quite be replicated on screen, and limitations are clear. Still, remote consultations turned out to be a practical lifeline for early evaluations, patient guidance, follow-ups, or simply keeping people informed when in-person contact was off the table. For those stuck in quarantine or living far from services, the virtual path helped keep some thread of continuity. Even now, outside the crisis window, teledentistry seems set to stay, especially where routine advice or check-ins are concerned.

Around the same period, interest from the scientific field gradually shifted toward saliva—its diagnostic role drew attention. Viral loads in oral fluids appeared remarkably high, and this naturally nudged researchers toward considering saliva as a viable option for COVID-19 detection, perhaps even preferable in some ways to the commonly used nasopharyngeal swab. Dental professionals, already operating within the oral cavity, found themselves unexpectedly positioned for involvement in screening initiatives and public monitoring. This shift nudged dentistry into a wider circle, intersecting more clearly with public health systems than was typical in the past. At the same time, the pandemic triggered fresh inquiry into the interplay between oral health and the virus's behavior inside the body. SARS-CoV-2's point of entry—ACE2 receptors—was discovered in oral tissues, particularly the gingiva and mucosal linings. That led to some speculation: could longstanding gum inflammation or neglected oral hygiene alter how vulnerable a person might be? Might it even shape the severity of the infection itself? Nothing firmly proven yet, but these theories opened new paths for collaborative studies that blur the traditional lines between dental and general medical science.

Educational environments went through a sudden, somewhat jarring transition. As in-person teaching came to a halt, dental programs moved their theory instruction into virtual spaces. The challenge came, more heavily, in the practical domain. Skill-based training, being a core of dental education, didn't shift as smoothly. Some institutions gave digital simulations a try. Others experimented with virtual reality activities or remote assessment tools. None of it fully matched the hands-on experience, but it helped to maintain some continuity. Gradually, and only where feasible, clinical practice restarted, usually with strict safety measures, spread-out sessions, and reduced group sizes. These circumstances brought attention to how vital adaptability is in course planning, also raised questions about how preparedness for public health crises should be woven into future dental curricula. Legal and ethical challenges emerged in parallel. Practitioners were left to weigh the urgency of treatment, assess cases without always knowing the infection status, and obtain valid consent in settings that felt quite altered. Clinic staff needed deep briefings and thorough documentation to avoid legal vulnerability. Professional bodies released protocols, adjusting them frequently. Yet, the speed of change often muddles understanding, leading to inconsistencies across practices.

Numerous obstacles appeared, yet the pandemic brought a rare spotlight onto resilience plus inventive spirit within dentistry. Cross-disciplinary cooperation surfaced, best practice notes were swapped, and unfamiliar digital tools were accepted early, methods that usually need long incubation. Fresh angles unfolded concerning airflow, sterilizing routines, and patient faith. Wider society started linking gums, teeth, and body defense, pushing stronger calls to weave oral care into emergency health plans.

Future path likely keeps COVID-19 shifts. Tighter infection barriers seem set to stay. Patient outlook altered; faith in safe chairs now critical. Dental teams may carry a larger weight in public health, especially for prevention or swift spotting of disease. Adaptability remains the core theme, found in appointment timing, training style, and service delivery. Flexible structures shield the craft if a new storm strikes.

Pulp Calcifications

Pulp calcifications are calcified formations with a base of organic matrix, which tend to appear inside the pulp cavity, whether in the coronal zone or down in the roots. Some occur loosely in the soft tissue, others might be fixed to dentin, or even embedded.[17] Radiographically, they mimic dentin quite closely, both in opacity and texture. Chemically, the dominant ingredients are calcium and phosphorus,[18] though traces of other elements like sodium, fluorine, iron, copper, magnesium, zinc, and potassium show up as well.[19] Sometimes, pulp stones are spotted alongside impacted teeth. The first molars show this most often, followed by second molars in both jaws—upper and lower. In contrast, incisors and canines rarely show this finding.[17] Their presence can obscure canal entrances, complicating root canal procedures, and possibly raise the risk of fracturing instruments during treatment. Studies vary widely when estimating how frequent pulp stones really are. Reported figures swing broadly—from as low as 8% all the way up to 90%—with no settled consensus across publications.[20]

Based on radiographic evaluations, some sources placed the prevalence somewhere close to 20% to maybe 25% overall.[21] Histological investigations tend to reveal a noticeably higher occurrence of pulp stones than radiographic studies, likely because masses under 200 µm often slip past radiographic detection.[17] Variability in reported prevalence appears linked to factors like ethnicity, biological sex, age brackets, and certain systemic health issues.

Dentin and pulp, though made of different tissues, function closely together as what's often termed the dentin–pulp complex. Around the margins of the pulp chamber, the biological role of odontoblasts centers mostly on dentin formation. These cells—mechanosensitive, immunocompetent—stay active despite being postmitotic.[22] During early tooth formation, they produce what's called primary dentin, laying down the initial structural framework. Later, once the tooth is functional, the same odontoblasts continue to secrete dentin, although more slowly—this is what defines secondary dentinogenesis.[23] A third mode exists, tertiary dentinogenesis, generally divided into two distinct forms: reactionary and reparative. In reactionary cases, a stimulus nearby seems to trigger resting odontoblasts to resume dentin secretion.[24] Reparative processes, on the other hand, take place after odontoblast death, initiating a repair mechanism where precursor cells are brought in, then transformed into odontoblast-like cells, which eventually begin secreting dentin again. This entire sequence has been well described.

Besides these pathways of dentinogenesis, several studies have highlighted the presence of calcifications deep within the pulp chamber. These pulp stones are often spotted during routine radiographic scans, particularly in teeth with extensive restorations or recurring mild trauma over the years. As for how common they are—well, that's not so clear.

Calcification within the dental pulp shows up in two general patterns—sometimes diffuse, other times more localized as distinct forms. Discrete types often lead to what's known as pulp stones, occasionally referred to as denticles or even small nodules. Diffuse patterns, on the other hand, tend to cause a gradual, balanced narrowing of both the pulp chamber and the radicular pulp spaces.[25] These pulp stones show up across a range of conditions—found in teeth that are healthy, those with disease, and occasionally in unerupted ones as well. Their calcium-to-phosphorus ratio tends to closely mirror that of dentin. Commonly, they occur more in the coronal portion of the pulp than deeper in the radicular canal. Radiographs typically catch them as dense, bright shapes inside the otherwise darker pulp area.[26] Structurally, pulp stones fall into two types—true and false. True ones are quite rare, made up of dentin that carries clear dentinal tubules, lined along the inside by odontoblasts. False forms arise from layered mineral build-up, collecting over time around elements like clotted blood, cellular debris, or collagen bundles. Their location also plays a role in categorization, leading to terms like embedded, attached, or free.[27]

Pulp stones hold a certain clinical relevance. Their calcified nature may interfere with access during root canal procedures, a point explored in several clinical discussions and reports.[28] Still, in the absence of clear symptoms or additional signs, pulpal calcification alone does not warrant endodontic intervention.[22] In this way, a pulp stone may cause trouble during root canal sessions. It might get in the way, sit at the canal opening, and make the whole process harder than expected. That's why knowing in advance about any internal blockages helps a lot in practice. Some papers suggest possible links between pulp stones and broader calcific conditions in the body. But the findings remain mixed. The topic, for now, still carries a fair amount of uncertainty in the current literature. One recent investigation reported no connection with bladder stones, whereas a different study observed that individuals presenting pulp stones may face nearly 5.78 times higher odds of developing kidney stones.[29] As for how often pulp stones occur, studies relying on radiographic screenings have shown a rather wide spread in prevalence figures—somewhere between 8% and up to even 50%.[28] This variation appears rooted in methodological diversity. A few reports focused on total tooth count; others concentrated on patient-level data or panoramic views like orthopantomograms. One such 2018 study from Kerala, India, looked into dental patients using OPGs and noted calcifications within pulp chambers, recording a prevalence of 28.9% in that sampled group.[30] Meanwhile, another investigation from Iran estimated a 9% occurrence when all examined teeth were considered, with gender showing no meaningful statistical effect on distribution.[31]

The exact cause behind pulp calcification remains somewhat unclear. Various contributing elements, though, have been linked to pulp stone development throughout existing literature. Among these are patient age, hereditary tendencies, tooth movement from orthodontics, circulatory disruptions such as pulpal trauma, and persistent irritants, including carious lesions or extensive restorations.[29] Several studies have pointed toward different possible contributors behind the development of pulp stones. Among them, internal pulp changes due to degeneration seem relevant. Periodontal complications often show some connection as well. Age, as it increases, might play a role, though not always clearly defined. Inherited traits in certain individuals may also tilt the scale. Some reports mention elevated oxidative stress or heightened alkaline phosphatase as possible biochemical contributors. In addition, when deep caries is present or dental worklike fillings are done, the resulting tissue disturbance can stir irritation, sometimes even persistent inflammation. Other contributors, like trauma or systemic issues such as atherosclerosis, have been mentioned too.[32] Conditions, including cardiovascular and renal diseases, along with the presence of gallstones or salivary calculi, were also noted as possible risks. Still, pulp stones appear across age ranges, often regardless of general health conditions.[31]

The role of age in pulp stone formation remains an unsettled matter. Not all studies point to a direct age link; rather, more weight seems to fall on how persistent, frequent, or strong certain irritants affect the pulp over time. Still, these calcified bodies appear more frequently among adults, though younger cases are not entirely absent either.[22] One pediatric-centered study observed a slow, steady increase with age, which could suggest some form of association. This pattern hints at the need for long-term studies to better map how age might influence their development across different life stages. On x-rays, pulp stones take the shape of small, rounded or oval bright spots within the pulp space—sometimes isolated and sharply defined, other times scattered, irregular, varied in contour or size. Common diagnostic imaging includes panoramic, bitewing, and cone-beam CT scans. Among these, panoramic views are particularly valued for capturing an overall look at both jaws and teeth in one frame, which helps in spotting such formations effectively. Panoramic radiography often proves useful in spotting pulp stones, or pulp calcifications, thanks to its broad field of view that manages to include both jaws in one go. Though cone beam computed tomography provides clearer detail, panoramic films still serve as a reasonable starting point less radiation involved, easier access, and often enough for catching these mineralized formations early on. Panoramic radiography often proves useful in spotting pulp stones, or pulp calcifications, thanks to its broad field of view that manages to include both jaws in one go. Though cone beam computed tomography provides clearer detail, panoramic films still serve as a reasonable starting point less radiation involved, easier access, and often enough for catching these mineralized formations early on. According to earlier reports, though these structures occasionally reside deep in the root, most tend to be in the coronal pulp area. When located far down near the apex of the root, they can block the canal, complicating the clinical procedure. In endodontic treatment, running into these stones may lead to challenges—changes in working length, accidental structural harm, even total failure of the process in some cases. This raises valid concerns regarding procedural risk and outcome predictability.

Materials and Methods

The study was performed at several specialized dental centers in Baghdad, Iraq, between May 2020 and July 2022. A study population of 600 patients was included in the study, independent of gender, between 18 and 50 years. These patients were referred to the radiology department for panoramic imaging and were divided into a "COVID-19 group and a control group". The "COVID-19" group consisted of 300 patients who presented with a history of COVID-19 disease confirmed using the RT-PCR test at least one-year post-recovery. The control group consisted of 300 individuals who presented with no history of COVID-19 infection as a standard for comparison with the COVID-19 group. Then, pulp calcifications were evaluated on panoramic images. All parameters of the panoramic x-ray system were adjusted to be similar to all panoramic images (kVp: 80 kV, mA: 10 mA and exposure time: 15 seconds). Mild, moderate, or severe COVID-19 cases were classified based on clinical and radiological examination. Mild cases involved non-hospitalized minor manifestations (like fever and cough). Moderate cases involved symptoms associated with oxygen therapy and short-term hospitalization. Severe cases were associated with pneumonia and ICU admission with ventilatory support.

Radiographic Analysis

Panoramic radiographs of each patient were examined, aiming to identify dental pulp calcifications. These showed up as radiopaque formations, seen either in the pulp chamber or running down the root canals. Three kinds noted:

1-Focal calcifications are confined to certain small spots in the pulp chamber.

2-Diffuse calcifications, more spread out, no clear boundary through the pulp space.

3-Total calcifications, when the whole chamber looked filled, almost packed, with calcified matter.

Exclusion Criteria

- Patients with pre-existing systemic diseases (e.g., diabetes, cardiovascular diseases, chronic kidney disease).
- History of dental trauma or dental procedures (e.g., endodontic treatment, orthodontic treatment) on the teeth evaluated.
- History of tooth sensitivity, dental infections, and symptomatic teeth
- History of medications (e.g., corticosteroids, bisphosphonates).
- Smokers and alcoholics.
- Patients with bad oral hygiene.

Statistical Analysis

The chi-square test was employed to assess differences in the prevalence of pulp calcification between the COVID-19 and control groups. Fisher's exact test was utilised to examine the correlations between the severity of "COVID-19" and forms of pulp calcification.

Results

The analysis indicated a significant difference concerning the impact of COVID-19 infection on the formation of pulp calcifications [Chi-square test = 3.9, p = 0.045; significance defined at p < 0.05], Table 1 and Figure 1. Subsequent evaluation also demonstrated a significant association between the severity of COVID-19 infection and the specific types of pulp calcifications identified [Fisher test p-value = 0.039; significance considered at p < 0.05]. In the COVID-19 group, pulp calcifications showed up at 5% in total. Mild cases had about 0.6%, moderate ones came in at 1.63%, and severe cases climbed to 2.6%. When zooming in on tooth types, maxillary first molars made up 2.6%, focal calcifications were 1.63%, and diffuse ones 0.97%. Mandibular first molar teeth showed 1.9%, evenly distributed between focal and diffuse forms. On the other hand, mandibular first molar teeth accounted for 1.9%, evenly distributed between focal and diffuse types. Maxillary premolar teeth were involved in 0.3% of cases; all cases are focal. Tables 2-4, and figures 2-4. In the control group, pulp calcifications showed up in 2% of the total cases. Focal pulp calcifications were found in 1.33% of maxillary first molars and 0.67% of mandibular second molars. No diffuse and total pulp calcifications were observed. Table 5 and Figure 5.

Table 1: Relationship between COVID-19 Infection and Pulp Calcifications.

Group	Cases without Pulp Calcifications	Cases with Pulp Calcifications	Total
Control group	294	6	300
Covid-19 group	285	15	300
Total	579	21	600

The chi-square = 3.9, *p*-value = 0.07. Not significant at *p-value* > 0.05.

Table 2: Tooth-specific Distribution of Pulp Calcifications According to COVID-19 Severity.

Tooth	Mild Cases n (%)	Moderate Cases n (%)	Severe Cases n (%)	Total n (%)
Maxillary 1st Molar	1 (0.3%)	3 (1.0%)	4 (1.3%)	8 (2.6%)
Mandibular 1st Molar	1 (0.3%)	2 (0.6%)	3 (1.0%)	6 (1.9%)
Maxillary Premolars	0 (0.0%)	0 (0.0%)	1 (0.3%)	1 (0.3%)
Total n (%)	2 (0.6%)	5 (1.6%)	8 (2.6%)	15 (5%)

Table 3: Distribution of the Types of Pulp Calcifications According to Affected Teeth in the COVID-19 Group.

Tooth	Focal Pulp Calcifications (n) (%)	Diffuse Pulp Calcifications (n) (%)	Total Pulp Calcifications (n) (%)	Total n (%)
Maxillary 1st Molar	5 (1.63%)	3 (0.97%)	0 (0.0%)	8 (2.6%)
Mandibular 1st Molar	3 (0.97%)	3 (0.97%)	0 (0.0%)	6 (1.9%)
Maxillary Premolars	1 (0.33%)	0 (0.0%)	0 (0.0%)	1 (0.3%)
Total n (%)	9 (2.6%)	6 (1.9%)	0 (0.0%)	15 (5%)

Table 4: Distribution of the Types of Pulp Calcifications According to COVID-19 Severity.

COVID-19 Severity	Focal Pulp Calcifications (n) (%)	Diffuse Pulp Calcifications (n) (%)	Total Pulp Calcifications (n) (%)	Total n (%)
Mild COVID cases	1 (0.3%)	1 (0.3%)	0 (0.0%)	2 (0.6%)
Moderate COVID cases	3 (1.0%)	2 (0.6%)	0 (0.0%)	5 (1.6%)
Severe COVID cases	5 (1.6%)	3 (1.0%)	0 (0.0%)	8 (2.6%)
Total	9 (2.6%)	6 (1.9%)	0 (0.0%)	15 (5%)

Table 5: Distribution of the Types of Pulp Calcifications According to Affected Teeth in the Control Group.

Tooth	Focal Pulp Calcifications (n) (%)	Diffuse Pulp Calcifications (n) (%)	Total Pulp Calcifications (n) (%)	Total n (%)
Maxillary 1st Molar	4 (1.33%)	0 (0.0%)	0 (0.0%)	4 (1.33%)
Mandibular 2nd Molar	2 (0.67%)	0 (0.0%)	0 (0.0%)	2 (0.67%)
Total n (%)	6 (2.0%)	0 (0.0%)	0 (0.0%)	6 (2.0%)

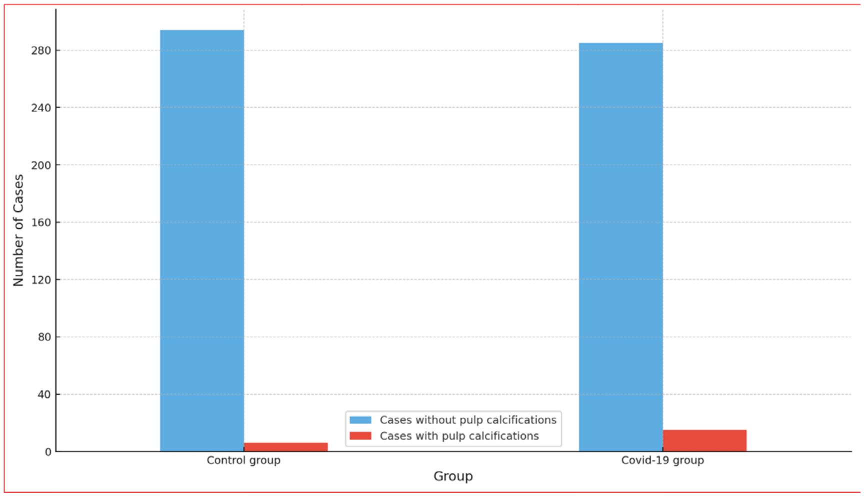

Figure 1: A Bar Chart Representing the Relationship between COVID-19 Disease and Pulp Calcifications.

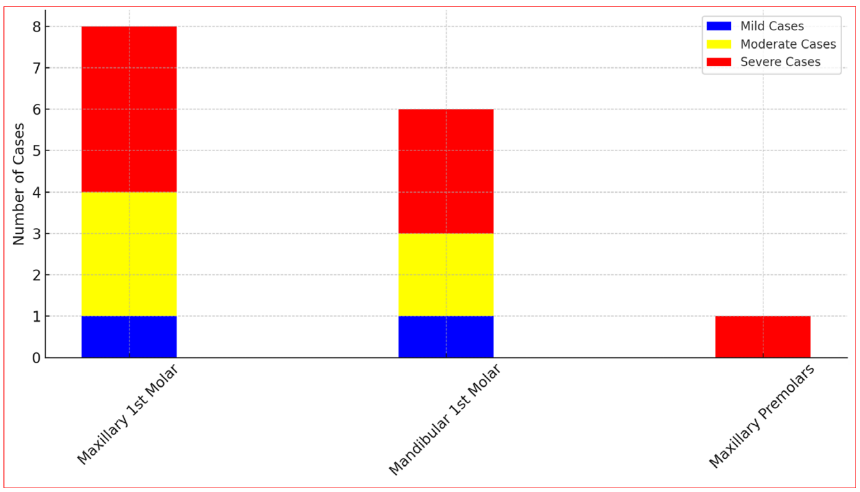

Figure 2: A Bar Chart Showing Pulp Calcifications by Tooth and COVID-19 Severity.

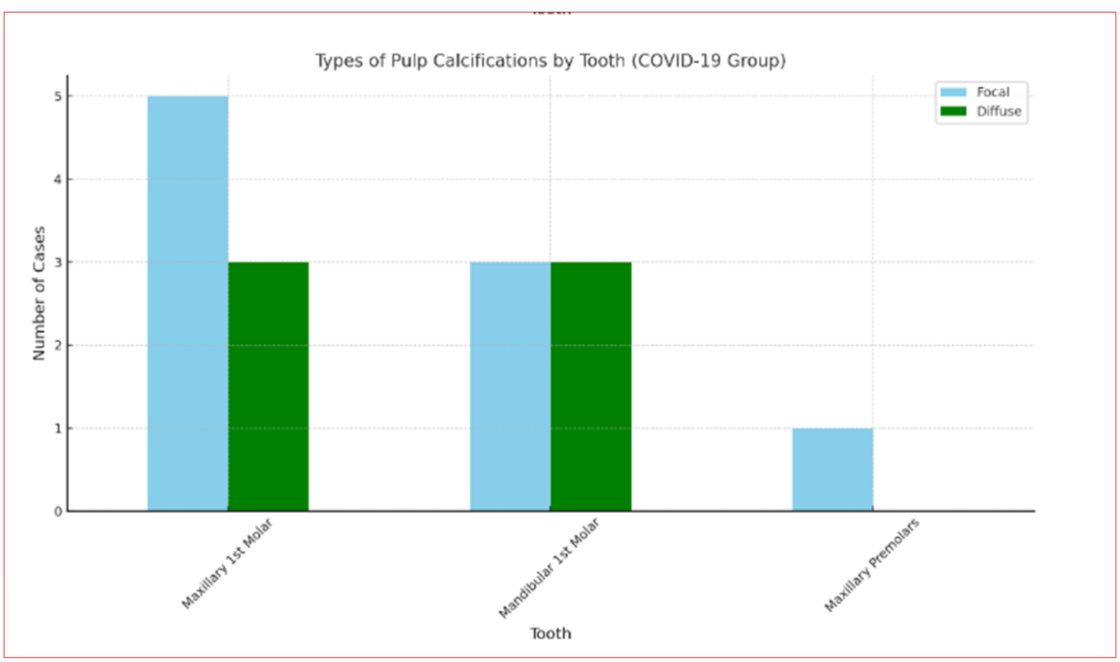

Figure 3: Bar Chart Showing the Distribution of Pulp Calcifications Types in Affected Teeth in the COVID-19 Group.

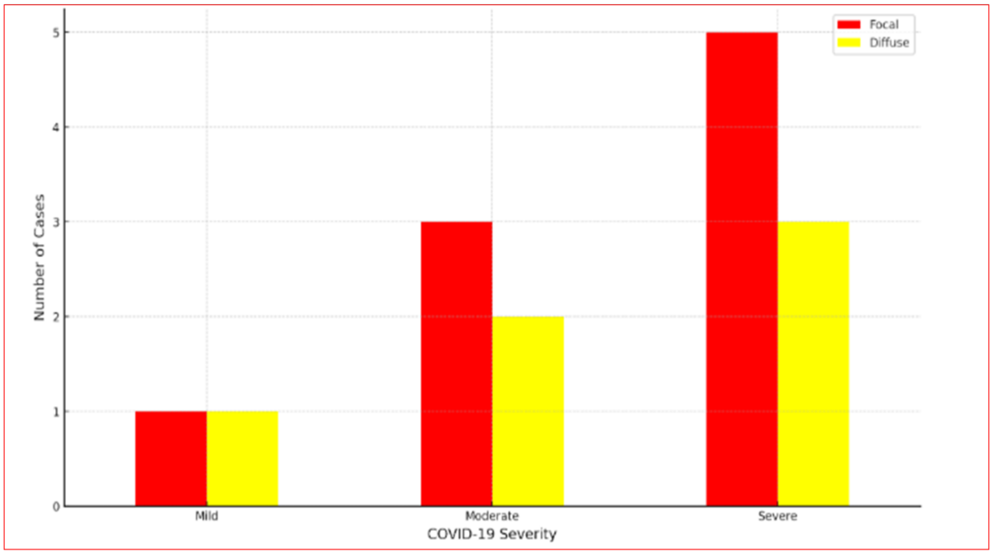

Figure 4: A Bar Chart Comparing Types of Pulp Calcifications Across COVID-19 Severity Levels.

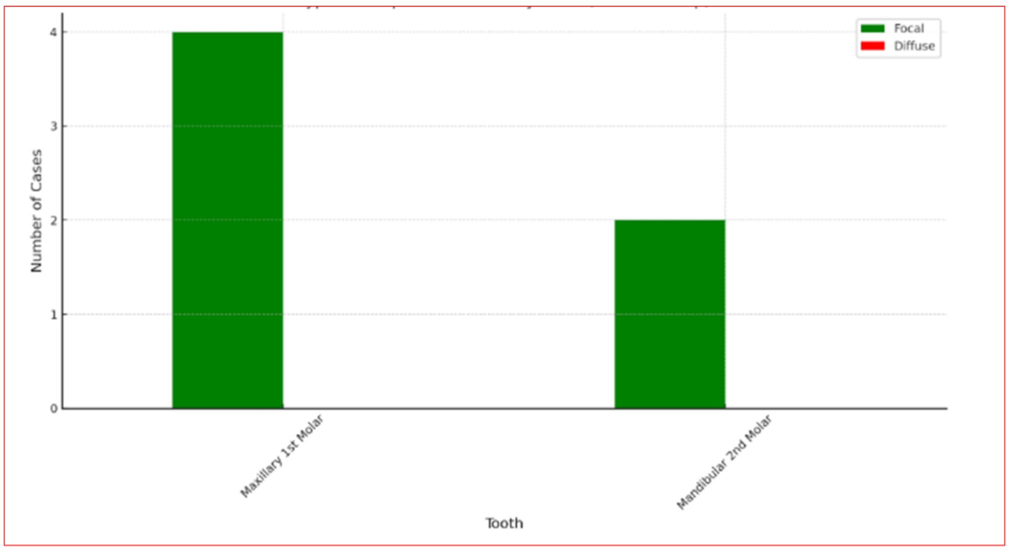

Figure 5: A Bar Chart of Pulp Calcifications in the Control Group by Tooth Type.

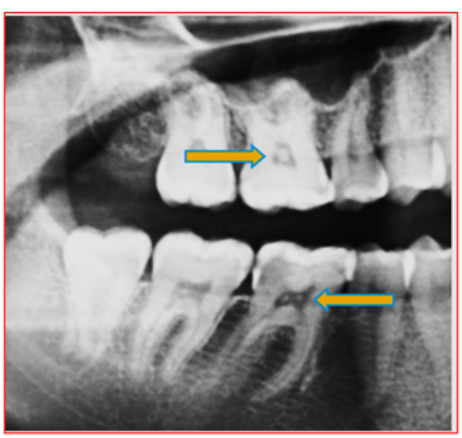

Figure 6: A Panoramic Radiographic Section of a 38-year-old Male Patient with COVID-19 History Reveals Focal Pulp Calcification in the Maxillary First Molar and Diffuse Pulp Calcification in the Mandibular First Molar.

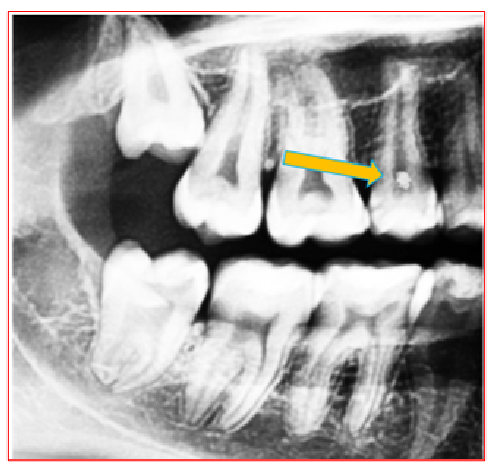

Figure 7: A Panoramic Radiographic Section of a 48-year-old Male Patient with COVID-19 History Reveals Focal Pulp Calcification in the Maxillary Second Premolar.

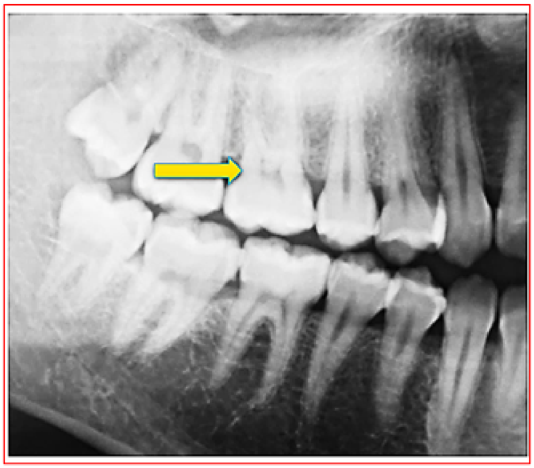

Figure 8: A Panoramic Radiographic Section of a 47-year-old Male Patient with COVID-19 History Reveals Focal Pulp Calcification in the Maxillary First Molar.

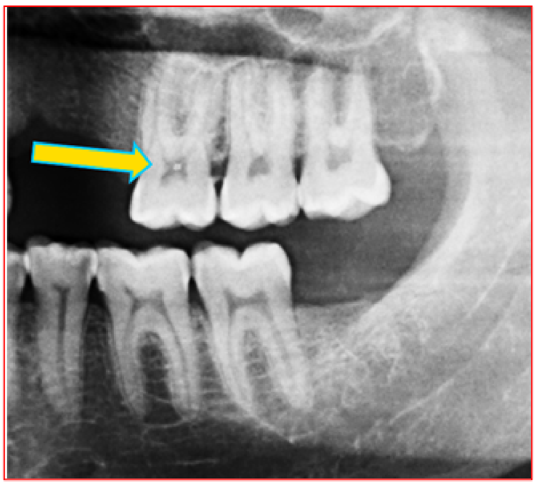

Figure 9: A Panoramic Radiographic Section of a 36-year-old Female Patient with COVID-19 History Reveals Focal Pulp Calcification in the Maxillary First Molar.

Discussion

COVID-19, caused by the SARS-CoV-2 virus, is an infectious disease mostly affecting the respiratory system. It induces several health issues that, in certain instances, lead to oral symptoms. The principal impacts are on the respiratory tract; nonetheless, the oral findings must not be disregarded. With the onset of the pandemic, routine dental care was abruptly interrupted in several regions. Only urgent cases are permitted. This abrupt disruption caused extensive delays in dental procedures. Individuals experiencing chronic oral issues—periodontitis, active caries, orthodontic complications—lacked adequate follow-up care. Particularly among children, the cancellation of preventive procedures such dental fluoride varnishes or fissure sealants may have contributed to a rise in caries incidence. The influence extended far beyond the mouth cavity. Oral infections frequently progressed, infiltrating the body's deeper systems. Conditions such as diabetes or cardiovascular disease became increasingly difficult to manage as dental health deteriorated. Concurrently, psychological burden intensified. Individuals suffered persistent pain, inflammation, or exacerbating conditions, while medical facilities remained closed. Weeks transformed into months. During that prolonged period of uncertainty, the role of dentistry in overall health began to clarify. It has consistently played a role, frequently subtle and often inconspicuous. However, under pressure, the link between dental health and systemic well-being has become increasingly difficult to overlook. It was conspicuous, unequivocally commanding attention.

The emergence of COVID-19 disrupted healthcare systems universally. Dentistry had a significant decline. A job centred on in-person interactions, particularly around the mouth and nose, abruptly encountered multiple levels of danger and uncertainty. As SARS-CoV-2 disseminated by droplets and lingered invisibly in the air, it disrupted the operations within dentistry clinics. What was previously considered typical started to seem uncertain. Previously automatic steps become increasingly complex. Daily, the difficulty evolved—maintaining safety while providing care. It constituted more than only a disruption of routine. At a deeper level, something already tenuous began to manifest. This was not merely a shock; it was a subtle yet persistent influence, gradually altering behaviours incrementally, with an increasing weight.

Dental settings inherently offer a certain degree of danger. Saliva. Haemoglobin. Suspended particulates in the atmosphere. All are components that a dental staff encounters routinely. Infected oral cavities often contain elevated viral loads, and procedures such as high-speed drilling or ultrasonic scaling can generate clouds of fine mist that permeate the environment. These suspended particles, particularly in environments devoid of substantial airflow, persist. The likelihood of exposure increased—not alone for the dentist, but for all those in proximity. Established habits and everyday routines started to be scrutinised. What was previously considered standard has become unsafe. Adjustments became imperative, leading to a reevaluation of numerous assumptions previously accepted by the profession. Consequently, prolonged infection indicates the necessity of regular dental evaluations for recovered individuals. This study examined the correlation between COVID-19 and the emergence of pathological changes in dental pulp. A viral infection may trigger pulp mineralisation via an inflammatory response and vascular changes in tooth tissues. The study demonstrated a substantial disparity in the impact of COVID-19 on the formation of pulp calcifications. The research identified a greater incidence of pulp calcifications in the COVID-19 cohort (5%) relative to the control cohort (2%). This suggests that SARS-CoV-2 infection may induce pulp mineralisation, potentially resulting in vascular alterations or inflammatory responses that impact dental pulp. The virus likely stimulates cytokines, resulting in increased TNF-α and IL-6, which may disrupt odontoblastic function and expedite calcification. Moreover, micro-thrombosis in pulp vessels diminishes blood flow, triggering ischaemic calcification due to prolonged hypoxia from respiratory difficulties, which may alter pulp metabolism and lead to calcific degeneration.

The notable correlation between Covid-19 severity and the types of pulp calcifications in this study indicates that increased disease severity correlates with higher occurrences of both localised and diffuse pulp calcifications. The findings indicate that vascular alterations and an inflammatory response associated with worsening COVID-19 may induce mineralisation processes in the tooth pulp. Pulp calcification may complicate endodontic therapy; thus, endodontists must diligently identify potential pulp calcifications in patients with a history of severe COVID-19. The limitation of a limited sample size in the present study underscores the necessity for more extensive research to further the understanding of the processes linking COVID-19 severity to dental pulp pathology. The control group exhibited a lower incidence of pulp calcifications (2%), signifying less inflammatory responses and diminished vascular alterations in this cohort.

The research indicated that the teeth most impacted by pulp calcifications in COVID-19 patients were the maxillary first molars (2.6%), succeeded by the mandibular first molars (1.9%), and less frequently observed in the maxillary first premolars (0.3%). Pulp calcifications were exclusively observed in 1.33% of maxillary first molars and 0.67% of mandibular second molars within the control group. Pulp calcifications observed more frequently in molars post-COVID-19 may be associated with the intricate anatomy of these teeth. Molars, subjected to significant chewing pressure, appear more susceptible to inflammation. This, consequently, promotes mineral formations. The infection induces micro-thrombosis and hypoxia, hence reducing pulp blood flow. Concurrently, the cytokine storm frequently accelerates fibrotic and calcific alterations. The resulting discomfort may last for an extended duration, exacerbating calcification. Furthermore, COVID-19 may disrupt calcium metabolism, promoting aberrant calcifications inside the pulp. These characteristics collectively indicate why molars appear particularly susceptible to pulp calcifications post-COVID-19, in comparison to other teeth Figures 6-9.

This study reveals a significant prevalence of pulp calcifications in patients with a history of COVID-19, which, while not well comprehended, may indicate temporary inflammatory responses or potentially enduring pulpal changes. The authenticity of these calcifications as genuine or as artefacts (potential false positives) remains ambiguous. The pattern persists. It necessitates thorough scrutiny, and further extensive research is required to elucidate ramifications. Relevance arises in clinical contexts. Dentists facing such calcifications may need to evaluate earlier COVID-19 infection as a potential contributory factor, particularly in unclear cases. While not obligatory, it is a possibility worth considering. Ultimately, viral infections, especially those with vascular and immunological implications, may not leave the pulp completely unscathed. The processes, however yet conjectural, may encompass microvascular alterations, immune-mediated reactions, or altogether different factors. Recognising these post-infectious effects may enhance diagnosis and perhaps modify treatment techniques, particularly in endodontics. The history of COVID-19 transcends mere background, evolving into a clinically pertinent setting. In instances where calcific alterations manifest without an apparent cause, they may be unforeseen and perplexing, as historical context could provide insight or guidance.

Conclusion

The study indicated a significant association between COVID-19 infection and a higher occurrence of pulp calcifications relative to control groups. Prolonged infection duration appeared to play a role in triggering calcific changes within the dental pulp. Such results underscore the relevance of including prior COVID-19 status during dental pulp assessments, especially in cases involving moderate to severe illness histories. Further extended research, alongside detailed histological investigations, remains necessary to determine if the observed calcifications are transient, gradually worsening, or linked to distinct pathological processes.

Ethical Approval

The study was conducted following the ethical standards of the Ethics Committee for Scientific Research at the College of Dentistry, University of Wasit., Ref. No. 142020 on 2/5/2020.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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Nil.

Conflicts of Interest

No conflict of interest.

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