

Are cribra orbitalia and porotic hyperostosis increasingly prevalent in Juveniles as a result of COVID-19?

Introduction

Porous cranial lesions (PCLs), such as cribra orbitalia (CO) and porotic hyperostosis (PH) (Figure 1), have long been of interest to bioarcheologists, and have been attributed to anemia, malnutrition, and other non-specific stresses (Cole and Waldron 2019; Steyn et al. 2016; Walker 2009). However, research on recently deceased individuals from New Mexico correlated the presence of CO and PH with respiratory infections (e.g., pneumonia and bronchitis) in the pre-COVID-19 era: O'Donnell et al. (2020) found that of 461 individuals, 112 had CO (24.3%), 58 had PH (12.6%), and 30 had both (6.5%). Further, odds ratios demonstrated that CO (OR = 3.92, p < .01) and PH (OR = 2.86, p = .02) were higher in individuals with respiratory infections compared to other causes of death (O'Donnell et al. 2020). Since March 2020, there have been over 771,407,825 COVID-19 cases and 6,77,023 deaths globally (WHO 2024). As COVID-19 represents a highly contagious upper/lower respiratory infection with mild-critical symptoms that most people have experienced, it is assumed that there may be a concomitant increase of CO and PH rates in the COVID-19 era. As such, this study examines if COVID-19 is correlated with porous cranial lesions and if CO and PH rates are increased in living and deceased juveniles.

Figure 1. Examples of CO and PH in various scoring stages through CT imaging (O'Donnell et al. 2020:725).



Materials and Methods

This study was comprised of 20 patients ranging in age from 5 months to 20 years (f=8; m=12) who tested positive for COVID-19 and had a cranial computed tomography (CT) scan on file from the Boston Medical Center (BMC). Prior to the beginning of data collection, the proposed research underwent institutional review board (IRB) approval and was approved (IRB H-44563). Additionally, data from 62 decedents ranging in age from 5 months to 20 years (f=25; m= 37) who underwent autopsy at the New Mexico Office of the Medical Investigator (Albuquerque, NM) between 2020 and 2023 were graciously provided by Dr. Alexis O'Donnell (College of Population Health, University of New Mexico). Of these, 16 individuals (f=6; m=10) tested positive for COVID-19 at autopsy. The CT scans of the living sample were viewed through Sectra UniView, which allowed for viewing both in 3D and in 1.5mm slices, and CO and PH were scored as present or absent. This allowed for chi-square and binary logistic regression statistical analyses and odds ratios to determine statistical significance between COVID-19 infection and the presence of CO and PH.

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Results

Of the 20 individuals who comprised the living COVID-19-positive data sample from the BMC, 45.0% exhibited PCLs, with nine cases of CO (45.0%), one case of PH (5.0%), and one individual with both CO and PH (5.0%). For the positive COVID-19 deceased sample, nine had CO (56.3%), 11 had PH (68.7%), and eight had both CO and PH (50.0%). Of the 46 individuals that comprised the deceased negative COVID-19 sample, 69.5% exhibited PCLs, with 14 cases of CO (30.4%), 31 cases of PH (67.0%), and 12 with both CO and PH (26.0%). The youngest individual to have both PCLs was 5 months old, and the oldest was 17 years old.

Chi-square analysis between COVID-19 status and the presence or absence of any PCL had statistical significance (p = <.001). In odds ratio analysis between COVID-19 status and the presence and absence of PCLs, OR = 0.56 indicates those with COVID-19 had lower odds of PCLs compared to those who tested negative (Table 1); however, binary linear regression showed this was not statistically significant (p = .027). For individuals both positive and negative for COVID-19, an odds ratio analysis was completed for the presence of both PCLs (OR = 0.6); Table 2). Chi-square analysis between COVID-19 status and the presence or absence of any PCL had statistical significance (p = <.001). Chi-square analysis demonstrated that there was no statistical difference between individuals, living or deceased, with CO and COVID-19 status (p = 1.076). The odds ratio of having CO (OR = 2.29) increased in individuals with COVID-19 compared to PH (OR = 0.242) or either PCL (OR = 0.56). For individuals both positive and negative for COVID-19, an odds ratio analysis was completed for the presence of both PCLs (OR = 0.6; Table 3). A statistically significant difference was found between PH and negative COVID-19 status in chi-square analysis, with p = .002, and the odds ratio was 0.242, which suggests that the odds of having PH decreased in people that have COVID-19 compared to those that tested negative for COVID-19 (Table 4). A statistical significance was also seen with binary logistic regression analysis (p = .002).

Table 1: Odds ratio of COVID-19 status and the presence and

COVID-19 status	Any PCL present	Any PCL absent
COVID-19 Positive	21	15
COVID-19 Negative	33	13

UK=0.56

Table 2: Odds ratio of COVID-19 status and the presence and absence of both CO and PH.

COVID-19 status	Both PCLs present	Both PCLs absent
COVID-19 Positive	9	15
COVID-19 Negative	12	12
OR=0.6		

Table 3: Odds ratio of COVID-19 status and the presence and absence of CO.

COVID-19 status	CO present	CO absent
COVID-19 Positive	18	18
COVID-19 Negative	14	32

OR= 2.29

Table 4: Odds ratio of COVID-19 status and the presence and absence of PH.

COVID-19 status	PH present	PH absent
COVID-19 Positive	12	24
COVID-19 Negative	31	15
OR=0.242		

absence of any PCLs.

Discussion/ Conclusion

Based O'Donnell et al.'s (2020) research, it was expected that those with COVID-19 would have an increased presence of PCLs. Rather, this study did not show a statistical significance between CO and COVID-19 infections, while a statistical significance was seen between PH and negative COVID-19 infections. COVID-19-negative individuals were more likely to show PH compared to COVID-19-positive individuals. Additionally, there were more cases of COVID-19 negative patents compared to those who were COVID-19 positive and had CO. There are many possible reasons as to why this data rejected the proposed hypothesis. The small sample size of the current study potentially impacted the data analysis as 82 individuals is much smaller than the 461 individuals utilized by O'Donnell et al. (2020). The lack of a statistical significance between PCLs and COVID-19 infection could also be due to complete remodeling of the lesions. Some individuals in the living COVID-19 positive sample from the BMC were older than when many cases of PCL are typically seen (O'Donnell et al. 2023). Another possibility is that COVID-19 infections may progress too quickly to produce PCLs. If the symptoms are mild to moderate, an active illness period is roughly one to two weeks; however, this can last months for more severe cases (Johns Hopkins Medicine 2025). This is a much shorter active period of infection compared to other respiratory infections such as pneumonia that are associated with PCLs (O'Donnell et al. 2020). Vaccination status may also play a role in the skeleton's response to these stressors; however, vaccination history for the current sample is unknown. Further research needs to be conducted to see if vaccination reduces PCLs; however, vaccines are known to limit the severity of symptoms, so it is possible in cases of less severity that the body does not undergo certain stress responses. Future research would benefit from looking at the timing of CO and PH appearing in CT scans following a period of respiratory infection or other longterm respiratory viruses in larger sample sizes. Further, research on the skeletal response to COVID-19 future could examine the presence of pleural rib lesions, which have been documented in those with pulmonary infections and tuberculosis (Roberts et al. 1994).

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