

A3 The Frequency and Pattern of Cardiopulmonary Resuscitation (CPR)-Related Fractures in an Infant Autopsy Sample

Miriam E. Soto Martinez, PhD*, Harris County Institute of Forensic Sciences, Houston, TX 77054; Jason M. Wiersema, PhD, Harris County Institute of Forensic Science, Houston, TX 77054; Julie M. Fleischman, PhD, Harris County Institute of Forensic Sciences, Houston, TX 77054; Deborah C. Pinto, PhD, Harris County Institute of Forensic Science, Houston, TX 77054; Christopher Greeley, MD, Houston, TX; Angela Bachim, MD, Baylor College of Medicine, Houston, TX 77030; Marcella Donaruma-Kwoh, MD, Texas Children's Hospital, Houston, TX 77030-2399; Si Gao, MS, Harris County Institute of Forensic Sciences, Houston, TX 77054; Laney R. Feeser, MA, SNA International, Omaha, NE

Learning Overview: The goal of this presentation is to evaluate the frequency of rib fractures related to CPR in an infant autopsy sample and to describe the observed pattern, including posterior rib fractures.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by drawing attention to the frequency of CPR-related rib fractures in an infant autopsy sample and describe the general pattern of CPR-related rib fractures, which is potentially valuable for forensic practitioners in differentiating therapeutic intervention from inflicted injuries.

Recent pediatric literature describes the occurrence of pediatric rib fractures associated with CPR as uncommon or rare.^{1,2} Two reasons why these studies may not be applicable to infant autopsy samples include: (1) the majority of research is based on radiographic studies, although acute rib fractures are notoriously difficult to identify radiographically; and (2) many of these studies were conducted prior to 2000 when the one-handed (or two-finger) CPR technique was recommended for infants.³ In 2000, the preferred technique for infant CPR was modified to the two-thumb technique when performed by two medical personnel.⁴ The current study builds on previous research by evaluating rib fracture data from a narrowly defined subset of the infants in the Infant Injury Database (IID).³

Based on published research, CPR-related rib fractures were hypothesized to occur most frequently on the anterior region of the ribs.⁵ It was also hypothesized, based on years of observation, that CPR-related rib fractures would: (1) occur more often on the left side than the right; (2) frequently occur on the posterior region; and (3) occur more frequently in younger infants. Non-parametric statistics and frequency data were used to evaluate these hypotheses and examine the distribution of CPR-related rib fractures.

The study sample consisted of 387 infants (≤ 12 mos. of age) autopsied at the Harris County Institute of Forensic Sciences from 2010 to 2020. All cases with skeletal injuries other than acute rib fractures, and cases with a cause of death classified as undetermined or trauma-related, were excluded. Manner/cause of death categories for these infants included undetermined/co-sleeping, undetermined/sudden unexplained death in infancy, natural/sudden infant death syndrome, natural/other (various causes of death related to natural disease), and accident/asphyxia or drowning. All infants had documented CPR and received a complete rib examination post-autopsy by a forensic anthropologist. CPR fractures were diagnosed in the context of preceding history lacking trauma and a predisposition to fracture, and the following fracture characteristics: acute fracture without signs of healing or inflammatory response, little to no periosteal hemorrhage, and primarily located in the anterior and/or anterolateral rib segments. Region of rib fracture was documented according to Love et al.⁶

Acute rib fractures likely associated with CPR were observed in 182 infants (47%). Infants with rib fractures were significantly younger than the infants without rib fractures ($U = 14,747, p < .001$). Eighty-five percent of the infants with rib fractures were between 0 and 4 months of age, with 1-month-old infants accounting for the greatest proportion of cases (~32%). Regarding infants with CPR-related rib fractures, there was a weak negative correlation between age and number of rib fractures ($r_s = -.22, p = .002$). The number of left-sided rib fractures was significantly greater than right-sided rib fractures ($Z = -3.64, p < .001$). Approximately 93% of rib fractures occurred on ribs 2–6, primarily in the anterior region (61%), followed by the posterior (~20%), anterolateral (~14%), and posterolateral (~2%). Anterior rib fractures occurred on ribs 1–9, with ~88% observed on ribs 2–5. Posterior rib fractures occurred on ribs 1–9, with ~80% occurring on ribs 2–6. Anterolateral rib fractures occurred on ribs 1–7, with ~96% occurring on ribs 2–6. Chi-square tests indicated a significant negative association between the occurrence of left anterior fractures and left posterior fractures ($\chi^2 = 18.34, p < .001$) and left anterior fractures and right posterior fractures ($\chi^2 = 15.04, p < .001$).

These findings indicate that CPR-related rib fractures occur significantly more often in younger infants, and, when present, are more numerous in younger infants. CPR-related fractures occurred primarily on ribs 2–6, more frequently on the left side than the right, and on the anterior region. While posterior rib fractures occur less frequently than anterior fractures, their occurrence is frequent enough to be significantly associated with left anterior rib fractures.

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*Presenting Author