



Autopsy assessment of pediatric head injury: a proposal for aerosol mitigation during the COVID-19 pandemic

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Abstract

During the Corona Virus Disease-19 (COVID-19) pandemic, there is still a requirement for post-mortems to continue, including those examinations performed in the context of medico-legal investigations. Currently, very little is known about how long this coronavirus can survive in deceased human bodies or whether un-embalmed human cadavers can be contagious to people who handle them. Therefore, it would appear to be prudent to consider implementation of additional safety measures for all necessary post-mortem procedures. During the post-mortem examination of babies and young children, it is important to open the calvarium to enable visualization of the brain and its coverings, particularly in cases where a head injury is likely to have occurred. Since October 2013, the use of neurosurgical equipment to open the calvarium during infant and young child autopsies has become routine practice in our unit. Both the neurosurgical craniotome and a standard oscillating mortuary saw produce particulate matter consisting of bone and body fluids (including blood) which can become aerosolized. Within this paper, we discuss the use of a transparent plastic tent whilst opening the calvarium during pediatric post-mortems, to reduce the spread of aerosols into the mortuary environment.

Keywords Post-mortem · Pediatric · Head Injury · COVID-19 · Corona Virus

In late 2019, a novel human coronavirus named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was discovered in Wuhan (China) in cases of fatal pneumonia [1]. Since its discovery, the virus has spread rapidly in the human population, with the clinical condition (Corona Virus Disease-19 (COVID-19)) being declared a pandemic by the World Health Organization (WHO) on March 11 2020. Common symptoms reported in patients infected with COVID-19 include fever, a new and continuous cough, shortness of breath, fatigue, loss of appetite, anosmia (loss of smell) and ageusia (loss of taste). The risk of significant disease, including pneumonia, is higher in older individuals [2], children have a milder clinical course [3, 4]. Current data suggests that children under 10 years of age account for only 1% of COVID-19 cases [5]. However, there has

been concern about the potential for increased transmission of COVID-19 due to asymptomatic pediatric patients with high viral loads [6].

There is still a requirement for post-mortems to continue throughout the COVID-19 pandemic, including those examinations performed in the context of medico-legal investigations. Currently, very little is known about how long SARS-CoV-2 can survive in deceased human bodies or whether un-embalmed human cadavers can be contagious to people who handle them [7]. Therefore, it would appear to be prudent to consider implementation of additional safety measures for all necessary post-mortem procedures.

SARS-CoV-2 is primarily transmitted between people through respiratory (droplet and aerosol) and contact routes, however airborne transmission may also occur in poorly ventilated indoor spaces [2]. In addition to respiratory secretions, SARS-CoV-2 has been detected in blood, feces and urine [2]. To reduce the risk of occupational transmission of COVID-19, current safety guidelines for mortuary personnel include the use of a FFP3 mask or alternatively, a battery powered air-purifying respirator [8].

During the post-mortem examination of babies and young children, it is important to open the calvarium to enable

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visualization of the brain and its coverings, particularly in cases where a head injury is likely to have occurred. Since October 2013, the use of neurosurgical equipment to open the calvarium during infant and young child autopsies has become routine practice in our unit. In contrast to the standard practice of removing the infant calvarial bones with infant skull shears or an electric oscillating saw, the use of a neurosurgical craniotome is minimally disruptive to the underlying soft tissues (the brain and the dura mater). The avoidance of autopsy-induced damage to the brain and dura is particularly useful when assessing these soft tissues in cases with pathological features of head injury (such as subdural hemorrhage). Both the neurosurgical craniotome and the standard oscillating mortuary saw produce particulate matter consisting of bone and body fluids (including blood), which can become aerosolized. The standard mortuary saw can, however, be fitted with a vacuum extraction cuff to collect airborne particles, thereby limiting their release into the surrounding environment. Currently, there is no such integrated extraction adaptor available for the neurosurgical craniotome.

When undertaking aerosol generating procedures in the mortuary (including the use of neurosurgical tools or an oscillating saw without a vacuum), additional safety measures have previously been described for potentially infectious cases (e.g. prion diseases). These measures have included the use of a plastic bag over the head of the deceased, saw, and arms of the saw operator, to reduce the amount of airborne particles released into the mortuary environment [9]. A more recent paper has described the use of a transparent plastic craniotomy box for removal of the calvarium during post-mortems on COVID-19 positive individuals [10].

At the beginning of the COVID-19 pandemic several principles were implemented to reduce the risk profile of

surgical procedures. These included the avoidance of aerosol generating procedures, if possible, and to minimize staff exposure and operation duration whenever possible [11]. Since the start of the COVID-19 pandemic we have employed these principles during autopsy practice. For all cases in which we remove the calvarium of a neonate, infant or young child using neurosurgical equipment, we have developed and adopted the use of a rectangular, transparent, plastic ‘tent’ to reduce the spread of aerosols into the mortuary environment (Fig. 1). Unlike previously described devices, our tent can accommodate the whole body of a deceased infant. With the whole body positioned within the tent, only one end of the bag requires an opening to enable access of the neurosurgical equipment and the operator’s arms. Furthermore, the operator can easily position the body of the deceased within the tent to enable access to the entire calvarium. The rigid supporting frame prevents collapse of the bag over the deceased and neurosurgical tools. The tent is simple to use, easy to sterilize and easy to store. The plastic bag is disposed of once the procedure is complete, and the supporting frame can be dismantled for appropriate disinfection and cleaning protocols. Reflection of the scalp can be undertaken before the deceased is placed into the tent and removal of the brain can be carried out once the aerosol-generating calvarial bone removal has been completed. The deceased can then be repositioned outside of the tent in order to facilitate brain extraction and further examination of the dura and skull base.

Currently, we do not have a detailed understanding of the likelihood of transmission of COVID-19 from aerosol generating procedures on deceased individuals. Anecdotally, as far as we are aware, the combination of PPE and use of the tent has prevented COVID-19 infection of mortuary staff, pathologists or other attendees at autopsies in our centre.

Fig. 1 Plastic transparent ‘tent’ used during the removal of the infant calvarial bones with neurosurgical tools



Until we acquire further understanding of the transmissibility of the virus, or we reach a point in time where the prevalence and risks of COVID-19 infection from cadavers has significantly decreased, the use of a plastic tent may provide an additional safety measure to reduce the risk of occupational transmission of COVID-19. Furthermore, the use of a plastic tent for calvarial bone removal may be useful for other known infectious diseases, or in future outbreaks caused by additional novel pathogens.

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020;382:727–33.
2. Public Health England. COVID-19: epidemiology, virology and clinical features. 2020. <https://www.gov.uk/government/publications/wuhan-novel-coronavirus-background-information/wuhan-novel-coronavirus-epidemiology-virology-and-clinical-features>. Accessed 11 Jan 2021.
3. Kelvin AA, Halperin S. Covid-19 in children: the link in the transmission chain. *Lancet Infect Dis*. 2020;20:633–4.
4. Lu X, Zhang L, Du H, Zhang J, Li YY, Qu J, et al. SARS-CoV-2 infection in children. *N Engl J Med*. 2020;382:1663–5.
5. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA*. 2020;323:1239–42.
6. Kam KQ, Yung CF, Cui L, Lin Tzer Pin R, Mak TM, Maiwald M, A well infant with coronavirus disease, , et al. with high viral load. *Clin Infect Dis*. 2019;2020(71):847–9.
7. Dijkhuizen LGM, Gelderman HT, Duijst WLJM. Review: The safe handling of a corpse (suspected) with COVID-19. *J Forensic Leg Med*. 2020;73:101999.
8. Osborn M, Lucas S, Stewart R, Swift B, Youd E. Briefing on COVID-19. Autopsy practice relating to possible cases of COVID-19 (2019-nCov, novel coronavirus from China 2019/2020). 2020. The Royal College of Pathologists. <https://www.rcpath.org/uploads/assets/d5e28baf-5789-4b0f-acecfe370eee6223/fe8fa85a-f004-4a0c-81ee4b2b9cd12cbf/Briefing-on-COVID-19-autopsy-Feb-2020.pdf>. Accessed 11 Jan 2021.
9. MacArthur S, Jacobson R, Marrero H, Rahman Z, Schneiderman H. Autopsy removal of the brain in AIDS: a new technique. *Hum Pathol*. 1986;17:1296–7.
10. Hasmi AH, Khoo LS, Koo ZP, Suriani MUA, Hamdan AN, Yaro SWM, et al. The craniotomy box: an innovative method of containing hazardous aerosols generated during skull saw use in autopsy on a COVID-19 body. *Forensic Sci Med Pathol*. 2020;16:477–80.
11. Wielogórska NL, Ekwobi CC. COVID-19: What are the challenges for NHS surgery? *Curr Probl Surg*. 2020;57:100856.

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