



The craniotomy box: an innovative method of containing hazardous aerosols generated during skull saw use in autopsy on a COVID-19 body

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Accepted: 25 May 2020 / Published online: 4 June 2020
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Abstract

During a disease pandemic, there is still a requirement to perform postmortem examinations within the context of legal considerations. The management of the dead from COVID-19 should not impede the medicolegal investigation of the death where required by the authorities and legislation but additional health and safety precautions should be adopted for the necessary postmortem procedures. The authors have therefore used the craniotomy box in an innovative way to enable a safe alternative for skull and brain removal procedures on suspected or confirmed COVID-19 bodies. The craniotomy box technique was tested on a confirmed COVID-19 positive body where a full postmortem examination was performed by a team of highly trained personnel in a negative pressure Biosafety Level 3 (BSL-3) autopsy suite in the National Institute of Forensic Medicine (IPFN) Malaysia. This craniotomy box is a custom-made transparent plastic box with five walls but without a floor. Two circular holes were made in one wall for the placement of arms in order to perform the skull opening procedure. A swab to detect the presence of the SARS-CoV-2 virus was taken from the interior surface of the craniotomy box after the procedure. The result from the test using real-time reverse transcriptase polymerase chain reaction (rRT-PCR) proved that an additional barrier provided respiratory protection by containing the aerosols generated from the skull opening procedure. This innovation ensures procedures performed inside this craniotomy box are safe for postmortem personnel performing high risk autopsies during pandemics.

Keywords COVID-19 · Autopsy · Craniotomy box · Aerosol-generating procedure · Safe alternative

Introduction

The new coronavirus belongs phylogenetically in the SARS-CoV clade and is called ‘Severe Acute Respiratory Syndrome Coronavirus-2’ (SARS-CoV-2), whereas the disease associated with the virus is referred to as Coronavirus Disease 2019 (COVID-19) [1]. Very little is known about how long SARS-CoV-2 can survive in dead

bodies or whether dead bodies can be contagious to people who handle them. According to the World Health Organization (WHO), there is no evidence to date of persons having become infected from exposure to the bodies of persons who died from COVID-19 [2]. However, there is the possibility that the virus also persists on deceased bodies since viable SARS-CoV-2 may persist on surfaces for days [3, 4]. Therefore, the safety and well-being of those in direct contact with bodies of cases of COVID-19 (both suspected or confirmed), particularly the autopsy team, should be of utmost priority. They should be protected from exposure to infected bodily fluids, contaminated objects, or other contaminated environmental surfaces [5]. This article describes the use of a transparent plastic box, known as a craniotomy box, during the removal of a COVID-19 deceased’s skull. The use of this box is

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an innovative way to contain the aerosols generated when performing skull and brain removal, and offers a degree of protection to the autopsy team.

Methods

Materials

A craniotomy box is a transparent acrylic plastic box measuring 60 cm × 60 cm × 55 cm (width (w) × length (l) × height (h)). The box has only 5 walls; the bottom of the box is left open or unsealed. Located on one wall adjacent to the bottom, two circular holes with a diameter (d) of 15 cm each are made so the prosector can insert their arms into the box (Fig. 1). There is an opening at the rear of the box of 15 cm (h1) to allow a vacuum suction to be placed and to provide an opening that allows the assistant to manipulate the head (Fig. 2).

In order to further reduce the risks to the personnel undertaking the autopsy, two disposable plastic sleeves are fixed onto the two circular holes on the inner side of the box to accommodate the prosector's arms (Fig. 3).

Safety considerations

Safety procedures employed for the dead infected with COVID-19 should be consistent with those used for autopsies on decedents who have died from an acute respiratory illness. The postmortem procedure should be performed by a team of adequately trained personnel for handling high-risk infectious cases donning full personal protective equipment (PPE) with Powered Air-Purifying Respirator (PAPR), including jumpsuit, impervious gown with full sleeve coverage, double surgical gloves and boots (Fig. 4).

Simulation exercise

A simulation exercise was conducted at the National Institute of Forensic Medicine (IPFN) Malaysia to assess the feasibility of using the craniotomy box during an actual autopsy. The position of the arms and hand

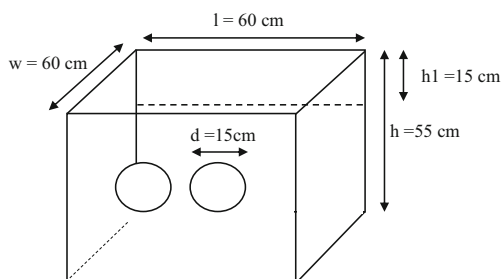


Fig. 1 Diagram of a custom-made craniotomy box (Front view)

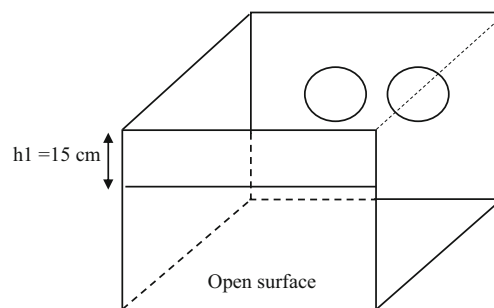


Fig. 2 Diagram of a custom-made craniotomy box (Rear view)

movement when using the skull saw and the degree of comfort of the operator were assessed.

Autopsy on a COVID-19 positive body

A complete postmortem examination was performed according to standard procedures for high risk autopsies in a negative pressure Biosafety Level 3 (BSL-3) autopsy suite at the National Institute of Forensic Medicine (IPFN) Malaysia by a team of four personnel consisting of a forensic pathologist, two medical officers and one medical assistant. The diagnosis of coronavirus disease 2019 (COVID-19) was confirmed by real-time reverse transcriptase polymerase chain reaction (rRT-PCR) testing on both clinical and postmortem swabs.

A complete autopsy requires the removal of the skull using a skull saw, and subsequent removal of the brain. This procedure is an aerosol-generating procedure that generates small-particle aerosols, which is highly risky to personnel conducting an autopsy on a COVID-19 patient. If a person died during the infectious period of COVID-19, the lungs and other organs may still contain live virus, and additional respiratory protection is needed during aerosol-generating procedures such as the use of power saws or washing of intestines [2]. To contain the

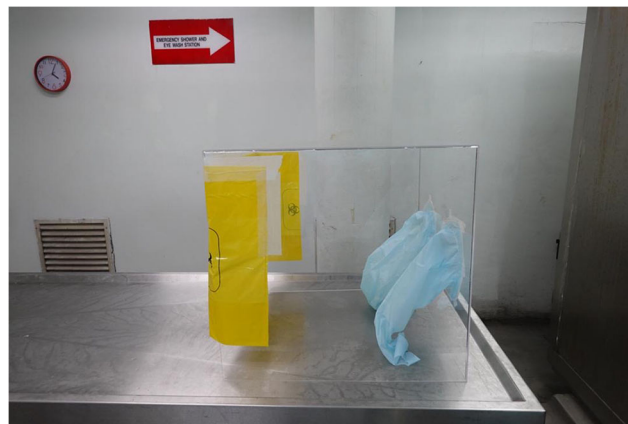


Fig. 3 A craniotomy box with disposable sleeves (side view)

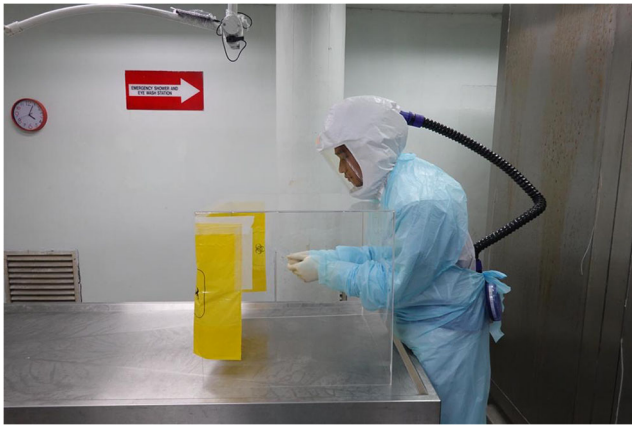


Fig. 4 Position of the hands and arms inside the craniotomy box with full PPE and PAPR

aerosolization from this step, the authors have innovated the use of a craniotomy box to perform the procedure. This craniotomy box is placed on the head region of the deceased in supine position on the postmortem table (Fig. 5). The sawing procedure is performed with an oscillating saw together with vacuum suction (Fig. 6). Swab samples from the interior surface of the craniotomy box for COVID-19 rRT-PCR were taken before and after the procedure to check for the presence of SARS-CoV-2. The analysis of these swabs was done by the Virology Unit of the Institute of Medical Research (IMR), Ministry of Health Malaysia.

Findings

Two swabs were taken from the interior surface of the craniotomy box, before and after the procedure, and sent

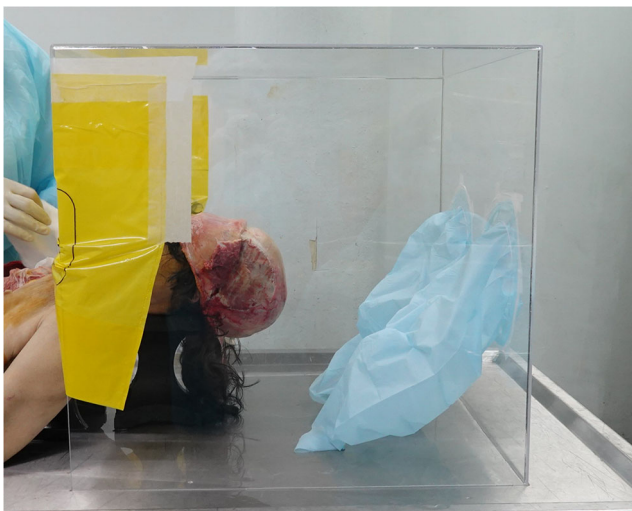


Fig. 5 The craniotomy box is placed on the head region of the deceased

to the Virology Unit of the Institute of Medical Research (IMR), Ministry of Health Malaysia for SARS-CoV-2 by rRT-PCR detection.

Aerosols and bone dusts are assumed to be deposited onto the inner surface of the craniotomy box after the skull opening procedure. The results from IMR showed virus was detected after the procedure meaning the bone dusts and aerosols generated were trapped within the box (Table 1). Aerosolized particles could be seen using the naked eye.

Discussion

Aerosol-generating procedures or procedures that can lead to splashes during post-mortem examinations carry a higher risk and require appropriate PPE [3]. In fact, there are several techniques undertaken at autopsy which can reduce the risks encountered by Hazard Group 3 organism (HG3) infections including SARS-CoV-2, such as minimizing sharps in the workspace, using round-ended scissors, blunt-ended PM40 blades and having only a single operator working in the body cavity at a time. Fresh organs should be sliced while being stabilized with a sponge on a solid surface [1, 3]. The authors have devised a safer process for postmortem craniotomy by means of a craniotomy box which appears to be able to limit and contain the aerosols generated from the skull opening procedure during a postmortem.

During the autopsy, the visibility of the personnel performing the procedure is not compromised as the box is transparent. Hand movement and maneuvering inside the craniotomy box is not impaired and compliance to the standard skull cut is maintained according to guidelines. The craniotomy box permits room for hand movement during the procedure. It is an acrylic plastic and can easily be fully disinfected after the autopsy by cleaning the inner and outer surface of the box or immersion into a pail of disinfectant solution. In fact, the box is washable



Fig. 6 Sawing procedure with vacuum suction

Table 1 Results from the virology unit of the Institute of Medical Research (IMR)

Specimen	Test	Specimen quality	Date collected	Date of test performed	Result
Inside box swab (before procedure)	Real Time RT-PCR for 2019 nCoV	In Viral Transport Media (VTM) / In ice	11 April 2020	14 April 2020	NOT DETECTED
Inside box swab (after procedure)	Real Time RT-PCR for 2019 nCoV	In VTM / In ice	11 April 2020	14 April 2020	DETECTED

and reusable. There is no need to assemble or dismantle the box before or after the autopsy procedure.

The COVID-19 rRT-PCR swab from the interior surface of the craniotomy box detected the presence of the virus after the autopsy was performed. This proves that the craniotomy box enclosed and confined the bone dusts and aerosols generated within the box during the skull opening procedure. The risk of infection to the personnel during postmortem examination can thus be greatly reduced. This novel idea of a transparent box is practical and easy-to-use, whilst useful to protect personnel from possible direct infection during full post-mortem examination. The management of the dead from COVID-19 should not impede the medicolegal investigation of the death where required by the authorities, such as sudden deaths, homicides and death in custody [5], and legislation in times of pandemic.

Conclusion

It is hoped that this innovation will be shared with all forensic disciplines in order for the craniotomy box to be used as an additional barrier when opening the skull on high risk infectious cases during a pandemic. This idea is proven to reduce the risk of personnel exposed to aerosols generated during this hazardous procedure. As a matter of fact, the craniotomy box is easy to use and permits room for hand movement during the procedure. It is worth noting that unnecessary contact with bodies should be minimized, however, when there is a medicolegal requirement to perform a full postmortem examination on a deceased, the craniotomy box allows an additional safe alternative. The safety of everyone who manages the dead

should be of first priority as we need to take care of people who take care of the dead.

Acknowledgements The National Institute of Forensic Medicine (IPFN) Malaysia greatly acknowledges the tremendous support and effort from the Director General of Health and the Director of the Hospital Kuala Lumpur throughout the duration of the battle against the COVID-19 pandemic. Special thanks also extended to the Virology Unit of the Institute of Medical Research (IMR) for the laboratory analysis. We would also like to express our gratitude towards the medical front liners and all first responders who are directly and indirectly involved in the management of the dead for all COVID-19 cases.

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