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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Importance, personal protective equipment, and our experience after first autopsies performed on COVID-positive deceased in Novi Sad, Serbia

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SUMMARY

Introduction/Objective Autopsy represents the gold standard for determining cause and mechanisms of death. With this paper, the authors wanted to acquaint colleagues with our experiences while performing autopsies of COVID-positive deceased patients.

Method The study included total of 12 autopsies related to COVID-19 infection, performed in our forensic pathology institution, from which one autopsy of suspected patient and 11 autopsies of confirmed COVID-positive patients. Confirmation of infection was obtained by antemortem polymerase chain reaction analysis of oropharyngeal and nasopharyngeal swabs and by postmortem swabs taken from upper airways and lungs.

Results In five cases, cause of death was directly attributed to COVID-19 infection. In two cases cause of death was due to heart attack, in two cases due to gastrointestinal hemorrhage, in one case due to multiple injuries, in one case due to trauma complications and in one case due to gunshot injury.

Conclusion Large number of autopsies in which cause of death has been established to be other than COVID, along with importance of these cases for litigation, strongly emphasizes the importance of forensic autopsy of COVID-positive deceased. If adequate personal protective equipment is used, there should be minimal exposure risk to virus remaining in body tissues.

Keywords: COVID-19; autopsy; PPE; cause of death

INTRODUCTION

At the end of the year 2019, cases of an unknown infectious disease, primarily targeting lungs and causing pneumonia of unknown etiology, were reported in Wuhan, China. The microorganism which was causing this infection was identified as novel corona virus and was named severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2) [1]. The disease, named coronavirus disease (COVID-19), soon spread across Asia, then Europe, and then all over the world causing a pandemic. Recently, the result of a retrospective analysis of postmortem obtained sample of vitreous humor, showed that the first case of COVID-19 infection in Republic of Serbia was registered on February 5, 2020 [2]. Although there are multitude of literature data that provides insights of clinical manifestations of infection with Coronavirus, there were not so many articles related to pathomorphological characteristics, especially at the beginning of the pandemic. The reason for this deficiency of data was because the pandemic plunged the whole world into a healthcare crisis and also into an economic crisis, that caused initial shortage of protective medical equipment [3, 4]. The primary focus was on saving patients' lives and not adding pressure to already overcrowded health institutions and overburdened mortuary systems. In some countries, autopsy rooms were even used as morgues [5]. Accordingly, autopsies did not seem important at the time.

After an initial delay, it soon became obvious that the role of forensic pathologists and performing autopsy procedures on COVID-positive deceased, is vital for gaining a better understanding of COVID-19 pathological mechanism [6, 7]. Autopsy results (macroscopic, microscopic, microbiological), give us insight of how the virus is spreading through an organism, which organs are more affected, or even about possible later effects of the infection on an organism. Furthermore, autopsy represents the best tool for determining the exact cause of death and, in some cases, manner of death as well.

There were a few reported articles about pathological findings of COVID-positive patients, obtained by conducting biopsies and minimal invasive autopsies or partial autopsies which were systematically presented by Maiese at all. [8] The first full autopsy report was published in February 2020, in China [9] and after those articles, others were reported as well. Also, articles about necessary safety measures while performing autopsies were given by health organizations and governments of various states [10–13].

In Serbia, autopsies are performed in forensic institutions if they are ordered by the prosecutor's

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Table 1. Autopsy and pathohistological findings (Ph)

No	Brain	Heart	Lungs	Liver	Kidneys	Cause of death	Comorbidity	Heart (Ph)	Lungs (Ph)
1	Brain autopsy not performed	680 g, left ventricle 2.3 cm, right ventricle 0.8 cm, heart valves dysfunctional	Edema, 1010 g, 1140 g, pneumonia	Stasis	Stasis, initial nephrosclerosis	Heart failure	/	Hypertrophy, myofibrosis	Edema, emphysema, macrophages in the alveoli
2	Brain autopsy not performed	540 g, infarction scar, thinned left ventricle wall, atherosclerotic occlusion of RIP 99%	980 g, 940 g, edema, hepatization, initial ARDS	Stasis	Stasis	Reinfarction	Hypertension, obesity	Infarction scar, myofibrosis	Hyaline membranes, edema, septa with proliferated connective tissue and lymphocytes
3	Anemic	Atherosclerosis, aortic valve stenosis, aortic, mitral and tricuspid valve insufficiency	Bilateral pneumonia	Anemic	Anemic	Hemorrhagic shock, gastrointestinal bleeding	Hypertension	Infarction scar	/
4	Nonspecific	Nonspecific	Left pneumothorax, left rupture, bilateral pneumonia	Nonspecific	Nonspecific	ARDS, sepsis, polytrauma	/	Myofibrosis	Massive bronchopneumonia, focal intraalveolar hemorrhage, hyaline membranes
5	Brain autopsy not performed	Vegetation on mitral valve, chronic cardiomyopathy	Adhesions, ARDS	Anemic	Anemic	Hemorrhagic shock, gastric ulcer, gastrointestinal bleeding	Obesity	Myofibrosis, hypertrophy	Hyaline membranes, edema, septa with proliferated connective tissue and lymphocytes, massive intraalveolar hemorrhage
6	Nonspecific	Nonspecific	ARDS, bilateral pneumonia	Rupture, suture dehiscence, abscess	Shock	Sepsis, peritonitis, subphrenic abscess	Hypertension	/	Edema, septa with proliferated connective tissue and lymphocytes, atelectasis
7	Nonspecific	Atherosclerosis, STENT	Bilateral interstitial pneumonia, pleural effusion 150 ml	Nonspecific	Nonspecific	Interstitial pneumonia, COVID-19	Coronary atherosclerosis	/	/
8	Nonspecific	Atherosclerosis	Bilateral interstitial pneumonia	Cirrhosis	Nonspecific	Interstitial pneumonia, COVID-19	Alcoholic, malnourished	/	/
9	Brain autopsy not performed	Nonspecific	Edema, lobar pneumonia	Stasis	Stasis	Interstitial pneumonia, COVID-19	Obesity	Myofibrosis, lipomatosis	/
10	Nonspecific	Hypertrophy, 500 g, moderate atherosclerosis	1300 g, 900 g, ARDS, pneumonia	Stasis	Nephrosclerosis, cysts, shock	ARDS, pneumonia, COVID-19	/	/	Edema, hyperemia
11	Nonspecific	600 g, mild atherosclerosis	ARDS, bilateral pneumonia	Stasis	Nonspecific	Pneumonia, COVID-19	Hypertension	Hypertrophy, acute infarction	Hyaline membranes, edema, septa with proliferated connective tissue and lymphocytes, emphysema
12	Subarachnoid hemorrhage, contusions, edema	Nonspecific	ARDS, peripheral emphysema	Abscess	Nephrosclerosis	Gunshot wound	/	/	Emphysema, anthracosis, edema

ARDS – acute respiratory distress syndrome

office (in accordance with the Criminal procedure code) or if it is in accordance with certain paragraphs of the Healthcare law. Consent of the deceased closest family, in these cases, is not necessary and they cannot call off an autopsy procedure. It looks very similar to laws in Austria, as stated in the article by Skok et al. [3].

METHODS

From the beginning of the pandemic, until the end of 2020, 12 autopsies related to COVID-19 infection were performed at our forensic institution, from which one autopsy of suspected patient and eleven autopsies of confirmed COVID-positive patients. For most of these cases confirmation of infection was obtained by antemortem polymerase chain reaction (PCR) analysis of oropharyngeal and nasopharyngeal swabs and in two cases postmortem swabs from upper airways and lungs were taken during autopsy procedure, and then analyzed by PCR. Result of one suspected patient came out negative after the PCR analysis of postmortem sample. All bodies were placed in cold storage at least 36–48 hours before the beginning of the autopsy, in order to minimize the possibility of infection of forensic practitioners. It is possible that infectivity is unlikely if the cycle threshold values are greater than 30, but more postmortem studies can clarify the survival interval of the virus in a dead body and how dangerous it is for forensic practitioners to perform an autopsy [14]. It could also explain the possibility of virus transmission from infected corpse to forensic practitioner reported in Bangkok, Thailand [15].

This research was approved by the Ethics committee of our institution.

RESULTS

During an autopsy, all recommended safety measures were followed and personal protective equipment (PPE) was used. After gaining autopsy results, the cause of death was directly attributed to COVID-19 infection in only five cases, in which death occurred due to pulmonary manifestations (viral pneumonia). In these cases, lungs were firm, heavy and edematous, with whitish, foamy liquid leaking over the cut surface. Microscopically, pneumocyte hyperplasia, lymphocyte infiltration, multinuclear giant cells, increase in alveolar wall thickness and focal presence of hyaline membrane were seen, which are typical changes in viral pneumonia and acute respiratory distress syndrome (ARDS). Some of the autopsy and pathohistological findings are presented in Table 1, but surely more autopsies of COVID-positive patients are needed for a better understanding of these findings and also for understanding the pathogenesis of SARS-CoV-2 that the whole world is struggling with [16].

In two cases, the cause of death was due to heart attack, in two cases due to gastrointestinal hemorrhage, in one case due to multiple injuries (polytrauma), in one case due to trauma complications (sepsis), and in one case due to brain trauma associated to gunshot injury. In some death cases, non-related directly to COVID-19 infection, mild to moderate form of viral pneumonia was present, so it was not always easy to opt for the exact cause of death, which brings us to another problem, especially present among clinical colleagues – proper filling of death certificates. To help resolve this dilemma, we emphasize that if a patient has died from viral pneumonia and/or ARDS related to COVID-19 infection, then these diagnoses should be put in part one of death certificate (primary cause of death, direct and indirect cause of death) and if a patient dies from other cause, but has been COVID positive prior to death, with mild or moderate pneumonia (he died with COVID but not from COVID), then diagnoses of COVID infection should be put in part two (disease or trauma that contributed to the cause of death).

DISCUSSION

From the very beginning of the epidemic, there were several recommendations that autopsies of COVID-positive deceased should not be performed, with the exceptions of medicolegal cases. A protocol of actions in the case of such patients has been issued by experts from our country in March 2020 [17]. As far as performing autopsy is concerned, recommendations were that autopsies of COVID-positive patients should not be performed, except in cases of forensic significance, and that they must be performed using the adequate PPE.

Advisory Committee on Dangerous Pathogens has categorized pathogens (Table 2) according to their risk of human infection [18]. SARS and Middle East respiratory syndrome related coronaviruses (including Sars-Cov-2), hepatitis virus B, C, D and E, HIV, rabies, poliovirus, dengue, Creutzfeldt-Jakob disease agent, *Echinococcus*, *Mycobacterium tuberculosis* and many others are representatives of group 3 (Table 2).

Table 2. Advisory Committee on Dangerous Pathogens hazard group definitions

When classifying a biological agent it should be assigned to one of the following groups according to its level of risk of infection to humans	
Group 1	Unlikely to cause human disease
Group 2	Can cause human disease and may be a hazard to employees; it is unlikely to spread to the community and there is usually effective prophylaxis or treatment available
Group 3	Can cause severe human disease and may be a serious hazard to employees; it may spread to the community, but there is usually effective prophylaxis or treatment available
Group 4	Causes severe human disease and is a serious hazard to employees; it is likely to spread to the community and there is usually no effective prophylaxis or treatment available

Staff working in autopsy rooms is at high risk of exposure to Sars-Cov-2, because of specific procedures, during which a large number of viruses are released into the air in the form of aerosols. To minimize the risk of infection, use of appropriate PPE during autopsy is required. Minimum



Figure 1. Minimum of personal protective equipment



Figure 2. Oscillator saw with suction of the bone aerosol

of PPE as well as other recommendations are explained and summarized in several articles [3, 5, 7, 12, 13, 19, 20]. Recommended PPE implies the use of surgical scrub suit worn under impermeable gown or apron with full sleeve coverage, double surgical gloves interposed with a layer of cut-proof synthetic mesh gloves, disposable N95 respirator, goggles or face shield that covers the front and sides of the face, surgical caps, shoe covers (Figure 1). Also, there should be limited number of personnel present in the autopsy room, and a single practitioner should be operating within the body cavity at a time. Round-ended scissors and blades with blunted points should be used to minimize the risk of mechanical injuries, an oscillator saw with suction of the bone aerosol (Figure 2) should be used for sawing the skull. The fact that we did not have this device from the very beginning is the reason why in the first few autopsies we did not open the skull (in accordance with the recommendations on staff protection). It is essential to have all the necessary equipment at your disposal, to avoid the need to leave the area to find additional items.

Our autopsy room had air exchange with negative pressure and air recirculation to the other rooms was restricted. We did not have special autopsy room for infectious corpses with downward air suction directly at the autopsy table or Biosafety level 3 autopsy room or Airborne infection isolation room or 3M Versaflo powered air purifying respirators with M-series headgear as stated in some recent papers [7, 20]. The necessity of listed safety measures are still controversial, but more and more experts believe that these protective measures are excessive [21]. After performing larger number of autopsies on COVID-positive patients, a consideration should be given to the idea of establishing a national database, that will make it easier to obtain all the necessary data for better understanding of pathophysiology, diagnosis and treatment of this disease [22].

CONCLUSSION

With this paper, the authors wanted to acquaint colleagues with their experiences and possible problems while performing autopsies of COVID-positive deceased patients. Autopsy is still the gold standard for determining cause of death, mechanism of death and in some cases manner of death as well. Here, we represent the first autopsies of COVID-positive deceased performed in our country, and since the beginning of writing this paper, there were even more autopsies performed in our institution. If adequate PPE is used, there should be minimal exposure risk to virus remaining in body tissues. Also, we remind that plenty of autopsies infected with pathogens from the same hazard group were routinely done during past years or even decades. Such a large number of autopsies, in which the cause of death has been established to be other than COVID, along with importance of these cases for litigation, strongly emphasizes the importance of referring COVID-positive deceased to a forensic autopsy.

Conflict of interest: None declared.

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Значај, адекватна заштитна опрема и наша искуства после првих извршених обдукција преминулих особа позитивних на ковид у Новом Саду, Србији

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САЖЕТАК

Увод/Циљ Обдукција представља златни стандард за одређивање тачног узрока смрти и механизма умирања. Овим радом желели смо да упознамо колеге с нашим искуствима у вези с вршењем обдукција покојника позитивних на ковид.

Метод У нашој форензичкој установи извршено је укупно 12 обдукција повезаних са инфекцијом вирусом корона, од којих се за једну особу сумњало да је позитивна, а за 11 болесника је било потврђено да су позитивни на ковид. Потврда инфекције добијена је раније урађеном анализом полимеразне ланчане реакције орофарингеалног и назофарингеалног бриса, као и постмортално узетим брисом горњих дисајних путева и плућа.

Резултати У пет случајева узрок смрти директно се везује за инфекцију вирусом корона. У два случаја узрок смрти наступио је услед срчаног удара, у два случаја због гастроинтестиналног крварења, у једном случају због вишеструких повреда, у једном случају због компликација трауме, а у једном случају због повреде нанете из ватреног оружја.

Закључак Већи број обдукција код којих је откривено да узрок смрти није директна последица инфекције вирусом корона, заједно са значајем који ова открића имају за текуће судске процесе, наглашавају важност вршења судскомедицинских обдукција над преминулима који су били позитивни на ковид. Уз коришћење адекватне личне заштитне опреме и придржавања одређених мера приликом вршења обдукције, ризик од изложености вирусу у телесним ткивима покојника је минималан.

Кључне речи: ковид 19; обдукција; лична заштитна опрема; узрок смрти