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ROLE AND SIGNIFICANCE OF TRACHEOTOMY IN INTENSIVE CARE UNITS IN CORONAVIRUS DISEASE 2019-POSITIVE PATIENTS

ULOGA I ZNAČAJ TRAHEOTOMIJE U JEDINICAMA INTENZIVNE NEGE KOD COVID-19 POZITIVNIH PACIJENATA

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Summary

Introduction. The role of tracheotomy in the treatment of patients with prolonged intubation in intensive care units is known and confirmed. In light of the global pandemic of severe acute respiratory syndrome coronavirus-2 infection and consequent coronavirus disease 2019, we present our experiences with tracheotomy in infected patients.

Material and Methods. A retrospective observational study of patients treated in intensive care units at the Clinical Hospital Center "Dr. Dragiša Mišović Dedinje" was carried out in the period from March 21, 2020 to May 14, 2020. **Results.** A total of 970 coronavirus disease 2019-positive patients were treated and out of that number, 116 patients were treated in intensive care units (12%), of which 49 patients (42%) were on non-invasive mechanical ventilation and 67 patients (58%) on intensive mechanical ventilation. The average age of the patients was 59.3 years; the youngest patient was 46, and the oldest 73 years old. Tracheotomy was performed in 24 patients (21%), in 13 males (54.1%) and 11 females (45.9%). The mean time from intubation to tracheotomy was 11.6 days. Of the 24 tracheotomized patients, 12 had a successful decannulation (50%) and were discharged from intensive care units, 6 had a lethal outcome, and 6 patients were in treatment.

Discussion. All the patients underwent tracheotomy in the hospital room, because we considered that any transfer and manipulation of these severe patients may lead to worsening of the generally serious condition. Although some guidelines recommend that it would be ideal to know the coronavirus disease 2019 status before any invasive procedure, we believe that this is not necessary, especially considering the clinical picture of patients during the pandemic, as well as computed tomography findings in the lungs. **Conclusion.** Tracheotomy has an important place in the treatment of patients with severe coronavirus disease 2019 infection since it provides easier maintenance of the airway, and in the recovery phase leads to easier transition of patients from mechanical ventilation to spontaneous breathing. The decision on the day when the tracheotomy will be performed is strictly individual and depends on the general condition of the patient, and the use of thermocautery does not affect the course of treatment and the final outcome.

Key words: Tracheotomy; Intensive Care Units; COVID-19; SARS-CoV-2; Risk Factors; Aerosolized Particles and Droplets; Personal Protective Equipment; Clinical Protocols; Prognosis

Sažetak

Uvod. Uloga traheotomije u lečenju dugotrajno intubiranih pacijenata u jedinicama intenzivnog lečenja je poznata i potvrđena. U svetlu svetske pandemije SARS-CoV-2 infekcije i posledične COVID-19 bolesti želimo da prikazemo naša iskustva sa traheotomijama kod zaraženih pacijenata. **Materijal i metode.** Urađena je retrospektivna opservaciona studija pacijenata lečenih u jedinicama intenzivnog lečenja u Kliničko-bolnički centar „Dr Dragiša Mišović-Dedinje“ u periodu od 21. 3. 2020–14. 5. 2020. godine. **Rezultati.** Lečeno je ukupno 970 pacijenata pozitivnih na COVID-19, a od ovog broja u jedinicama intenzivnog lečenja lečeno je 116 pacijenata (12%), od toga je 49 bolesnika (42%) bilo na neinvanzivnoj mehaničkoj ventilaciji a 67 bolesnika (58%) na intenzivnoj mehaničkoj ventilaciji. Prosečna starost pacijenata bila je 59,3 godine, najmlađi pacijent imao je 46 godina, a najstariji 73 godine. Traheotomija je urađena kod 24 pacijenta (21%), i to kod 13 osoba muškog pola (54,1%) i 11 kod osoba ženskog pola (45,9%). Prosečno vreme od intubacije do traheotomije bilo je 11,6 dana. Od 24 pacijenta, kod 12 je uspešno urađen dekanilman (50%) i otpušteni su iz jedinica intenzivne nege; kod šest je došlo do letalnog ishoda, a kod šest pacijenata lečenje je bilo u toku. **Diskusija.** Kod svih pacijenata je traheotomija urađena u bolesničkom krevetu jer smo smatrali da svaki transfer, prebacivanje i manipulacija oko ovih teških bolesnika može dovesti do pogoršavanja opšteg teškog stanja. Iako neki vodiči preporučuju da bi bilo idealno znati COVID status pre bilo kakve invazivne procedure, smatramo da to nije neophodno, posebno ako se ima u vidu klinička slika pacijenta u vreme pandemije, kao i nalaz kompjuterizovane tomografije pluća. **Zaključak.** Traheotomija ima značajno mesto u lečenju pacijenata sa teškim oblikom COVID-19 infekcije i ogleda se u lakšem održavanju disajnog puta, a u fazi oporavka dovodi do lakšeg prevođenja pacijenata sa mehaničke ventilacije na spontano disanje. Odluka o danu kada će se izvršiti traheotomija je strogo individualna i zavisi od opšteg stanja pacijenta, a primena termokautera ne utiče na tok i krajnji ishod lečenja.

Ključne reči: traheotomija; jedinice intenzivne nege; COVID-19; SARS-CoV-2; faktori rizika; kapljice i čestice aerosola; lična zaštitna oprema; klinički protokol; prognoza

Abbreviations

COVID-19	– coronavirus disease 2019
ICU	– intensive care unit
SARS-CoV-2	– severe acute respiratory syndrome coronavirus-2
CT	– computed tomography
PCR	– polymerase chain reaction
NIV	– non-invasive ventilation
IMV	– invasive mechanical ventilation

Introduction

Tracheotomy is an operative procedure known since ancient times. It is assumed that Asclepiades was the first to perform it, which was later confirmed by Galen and Aretaeus.

Tracheotomy is an integral and often necessary part of treatment of patients with malignant tumors of the larynx and pharynx, and its role in the long-term treatment of intubated patients in intensive care units (ICUs) is known and confirmed. In light of the global pandemic of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection, and consequent coronavirus disease 2019 (COVID-19), we presented our experiences with tracheotomy in infected patients.

Tracheotomy is defined as an aerosol-generating procedure and healthcare workers are at high risk of infection despite adequate Personal Protection Equipment 1. As a result, numerous guidelines for safe tracheotomy in COVID-19 patients emerged very quickly after the outbreak of the pandemic. All these guidelines are based on knowledge and experience with previous epidemics of viruses H5N1-bird flu, H1N1- swine flu, and MERS-CoV - Middle East respiratory syndrome-related corona virus.

Most of the world's tracheotomy guidelines agree that it would be ideal to know the COVID-19 status before surgery. In situations where this is impossible or limited, and the clinical picture, laboratory tests and computed tomography (CT) findings speak in favor of COVID-19, one should act as if COVID-19 was confirmed [1]. Then, it is necessary to take all personal protective measures of the team involved in the tracheotomy, as well as the staff at the ICU.

All tracheotomies were performed in hospital rooms, in order to avoid transportation to the operating room and manipulation of these severe patients, as well as to avoid worsening of the already serious general condition of patients.

The decision on the need to perform tracheotomy was made jointly by the anesthesiologist, intensivist, and surgeon, and the time of surgery was determined for each patient, depending on the general condition and severity of the clinical picture of the patient with COVID-19.

Guided by all preventive measures recommended for work with COVID-positive patients, as well as recommendations given by several world teams [1–4], all personnel protection measures have been taken, a team of experienced doctors has been appointed, and the number of people participating in the procedure and the tracheotomy itself has been

reduced to eliminate the possibility of aerosolization of the virus.

Lung CT has a very important place in the diagnosis and monitoring of COVID-19-positive patients, given the characteristic findings and high sensitivity and specificity. For that purpose, the Total CT Severity score: CO-RADS 6 COVID-19 stage was introduced in the Clinical Hospital Center "Dr. Dragiša Mišović Dedinje", which is an excellent prognostic factor for monitoring and outcome of the disease.

Indications for tracheotomy in COVID-19 patients

The indications for tracheotomy included:

- Separation from mechanical ventilation
- Clearance of secretions
- Acute respiratory distress syndrome
- Pulmonary edema
- Reducing the need for sedation
- Reintubation
- Extracorporeal membrane oxygenation.

Types of tracheotomy in COVID-19 patients

As in non-COVID conditions, there are two options for performing tracheotomy - open, surgical tracheotomy, and percutaneous dilatation tracheotomy. Given the possibilities, equipment, experience and anticipated duration of the procedure, preference was given to open surgical tracheotomy, rather than to percutaneous dilatation tracheotomy.

Material and Methods

The team performing tracheotomy includes two most experienced surgeons, an anesthesiologist, and two nurse practitioners. All the other personnel working in the ICU must be at an adequate distance or absent, all in order to reduce the possibility of infection during the surgery. All team members must have the highest level of personal protection. It is recommended that the operation be performed in rooms with negative pressure, if it is possible.

The biggest problem when performing tracheotomy in intubated patients is that the lung ventilation must be achieved through a respirator, and at the moment of opening the trachea, there is a great possibility of aerosolization. Some authors report the presence of SARS-CoV-2 virus in the air up to 3 hours after exposure [2]. For this purpose, the procedure has been modified and adjusted.

The preparation of patients is the same as in any surgical tracheotomy; maximum extension of the neck, with the head in retroflexion, and a maximum exposure of the neck is of key importance. Preparation of the operation field is standard and involves wiping the field with antiseptic solution (povidone-iodine) and covering it with sterile compresses. In order to reduce the possibility of spreading the virus, a high-power aspirator is necessary.

All patients underwent a tracheotomy using a horizontal incision of the skin and platysma, about

2 - 3 cm in length, then a vertical incision of the deep neck fascia, movement of the pothioid muscles laterally and presentation of thyroid isthmus. In all patients, the isthmus was dissected, ligated, and cut, and then moved to the side for better visualization of the anterior tracheal wall. Before opening the tracheal window, a complete neuromuscular block is necessary, in order to eliminate the cough reflex and swallowing.

When the anterior wall of the trachea is exposed and adequate hemostasis is achieved, the anesthesiologist stops mechanical ventilation, discharges the cuff from the tube and inserts the tube as caudally as possible, inflates the cuff again and continues with mechanical ventilation, which takes place lower than where the trachea will open. Constant patient monitoring is required. The anterior wall is opened with a scalpel and scissors by a horizontal intercartilaginous incision between 2nd and 3rd rings and then two vertical incisions are made, thus creating a flap (Bjork flap) whose base is below and which is then fixed to the skin with three non-absorbable sutures.

The anesthesiologist then stops the mechanical ventilator, dispenses cuff on the tube and gently pulls the tube above the window on the trachea, the surgeon inserts a tracheal cuff cannula, inflates the cuff and connects it to the mechanical lung ventilation system. The cannula is fixed either with skin sutures or neck straps provided for fixation.

We believe that this way of performing tracheotomy reduces the risk of infection in the team performing the operation, the time needed for the procedure is shorter than with other methods of tracheotomy (percutaneous dilatation tracheotomy), and the Bjork flap technique itself allows quick and efficient replacement of tracheal cannula in ICU by nurses or other staff, at times when a surgeon is not available.

We are proud to point out that none of the team members who participated in tracheotomies showed signs of SARS CoV-2 infection.

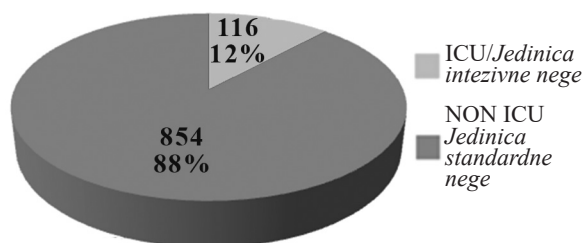
A retrospective observational study of patients treated in ICU at the Clinical Hospital Center "Dr. Dragiša Mišović Dedinje" was performed in the period from March 21, 2020 to May 14, 2020. All tracheotomized patients were COVID-19-positive, as evidenced by nasopharyngeal swabs by polymerase chain reaction (PCR). The average age of patients was 59.3 years; the youngest patient was 46, and the oldest 73 years old.

Results

In the aforementioned period, a total of 970 COVID-19-positive patients were treated at the Clinical Hospital Center "Dr. Dragiša Mišović Dedinje" and out of them, 116 patients were treated in the ICUs (12%) (**Graph 1**).

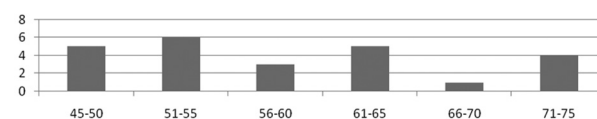
A total of 24 patients were operated, 13 males (54.1%) and 11 females (45.9%).

The average age of patients was 59.3 years; the youngest patient was 46, and the oldest 73 years old. The age distribution of patients is shown in **Graph 2**.



Graph 1. Number of treated patients in standard care and ICUs in the period from March 21, 2020 to May 14, 2020

Grafikon 1. Broj lečenih pacijenata u jedinicama standardne nege i intenzivne nege u periodu od 21.03.2020-14.05.2020.

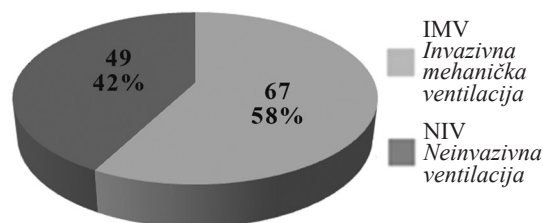


Graph 2. Age distribution of operated patients

Grafikon 2. Starostna struktura operisanih pacijenata

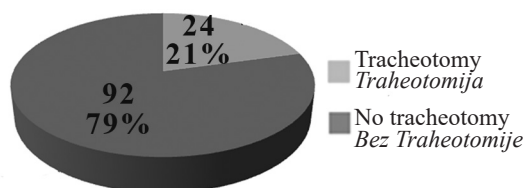
Of the total number of patients in ICUs, 116 patients were on some type of mechanical ventilation; 49 patients (42%) were on non-invasive mechanical ventilation (NIV) and 67 patients (58%) on intensive mechanical ventilation (IMV), that is, they were intubated and on artificial ventilation. The ratio of patients on invasive and non-invasive mechanical ventilation is shown in **Graph 3**.

Surgical tracheotomy was performed in 24 patients treated in ICUs (21%).



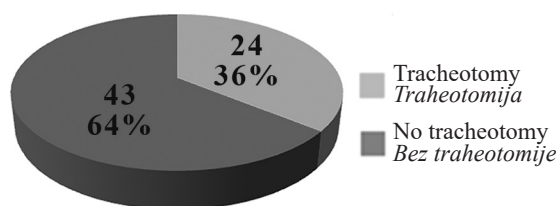
Graph 3. Number of patients on non-invasive ventilation and on invasive mechanical ventilation

Grafikon 3. Broj pacijenata na neinvanzivnoj ventilaciji i na intenzivnoj mehaničkoj ventilaciji



Graph 4. Total number of patients treated in ICUs (N = 116) and number of tracheotomies performed (N = 24)

Grafikon 4. Ukupan broj lečenih pacijenata u jedinicama standardne nege (N=116) i broj urađenih traheotomija (N=24)



Graph 5. Number of intubated patients on IMV and number of tracheotomies

Grafikon 5. Broj intubiranih pacijenata na intenzivnoj mehaničkoj ventilaciji i broj traheotomija

However, if the number of intubated patients (N = 67) who underwent tracheotomy is examined, the percentage is higher and amounts to 36% (**Graph 5**).

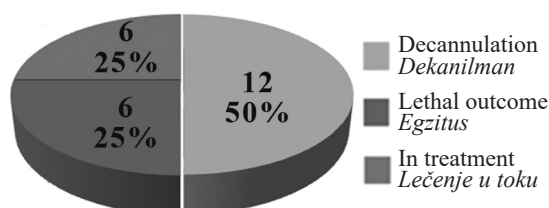
Of the operated patients, 15 had bilateral pneumonia, two (N = 2) patients had unilateral pneumonia, four (N = 4) had acute respiratory distress syndrome, one (N = 1) showed atelectasis, and one (N = 1) only had an enhanced bronchovascular pattern, all confirmed by chest X-ray.

Lung CT was performed in 11 patients and CO-RADS 6 COVID-19 score was determined, but due to technical reasons and severe general condition, lung CT was not performed in 13 patients. Total CT severity score in tracheotomized patients was 6 – 16, and average 11.8.

In regard to comorbidities, most intubated patients in ICUs (65.2%) had numerous comorbidities, (most often arterial hypertension, diabetes mellitus, hyper or hypothyroidism, gastritis, obesity, conditions after mastoidectomy, Hodgkin's lymphoma, gout, renal calculi, etc.) in addition to pneumonia caused by SARS-CoV-2, leading to serious conditions and the need for endotracheal intubation and mechanical ventilation. In our study, presence of associated chronic diseases was not determined in 8 patients (34.7%).

The average time from intubation to tracheotomy was 11.6 days, and 3 tracheotomies were performed within 7 days (early tracheotomy) on the second and fourth day due to pneumomediastinum, and in one patient on the third day due to severe deterioration and complete dependence on mechanical ventilation.

Of the 24 tracheotomized patients, successful decannulation was performed in 12 (50%) and they



Graph 6. Total treatment outcome at the end of the study period

Grafikon 6. Ukupan ishod lečenja pacijenata na kraju posmatranog perioda

were discharged from ICUs, 6 had a lethal outcome, and 6 patients were still in treatment (**Graph 6**).

Postoperative bleeding complication occurred in one patient (N = 1) and it was repaired during the same day. Partial pneumothorax occurred as a complication of mechanical ventilation in two patients (N = 2) and pneumomediastinum in two (N = 2), which was also successfully surgically resolved. The average time to replace the tracheal cannula was about the 10th day (+/- 3 days).

Discussion

Since the SARS-CoV-2 pandemic first appeared abroad, there are many unknowns about the treatment of COVID-19-positive patients. Of particular importance is the fact that a large number of patients need to be treated in ICUs, and the rapid tendency of the virus to spread and transmit is of particular concern. Therefore, it is necessary to apply all personal protection measures when treating these patients, and special care is necessary during any intervention or surgery.

All patients underwent tracheotomy in the hospital room, because we thought that any transfer and manipulation in these seriously sick patients could lead to a worsening of the generally severe condition. The authors claim that the incidence of patients in intensive care units is 3 – 15%, so our data of 12% are in line with the expected statistics [1].

Although some guidelines [2–9] recommend that it would be ideal to know COVID status before any invasive procedure, and even recommend postponing it until a positive PCR test is obtained, we believe that this is not necessary, especially considering the clinical picture of patients during the pandemic, and since CT findings in the lungs are highly specific and sensitive to COVID-19.

There are numerous controversies in the treatment of the most severe COVID patients in ICU, especially regarding the use of tracheotomy, given that even in conventional conditions there is no consensus on optimal timing of tracheotomy in intubated patients in ICUs.

Timing of tracheotomy

European guidelines for tracheotomy in COVID-19-positive patients recommend tracheotomy as early as possible, while guidelines from the United Kingdom, United States of America, Singapore and South Africa have a less aggressive approach, i.e. recommend tracheotomy after 14 days of intubation [4–6, 10–14].

Recent studies indicate that the results of early versus late tracheotomy are almost identical, so a decision is necessary for each patient individually [15, 16]. Although we had in mind the existing recommendations, individual approach was necessary for all patients, so the timing of tracheotomy was determined after consultations between the anesthesiologist and surgeon.

McGrath BA, et al. recommend that the “optimal window” to perform a tracheotomy in ICU in these patients is between 16 – 28 days, which corresponds to the 16th to 30th day from the onset of symptoms.

The first antibodies that can be detected in the blood is from 3 – 7 days, and at the same time, the detectability of SARS CoV-2 by PCR is reciprocally declining. Therefore, the authors recommend this time period for tracheotomy, since the virus disappeared from the upper respiratory tract and the body has created enough antibodies against the virus [15].

However, other authors believe that early tracheotomy, by the 10th day of intubation, is not less effective than late tracheotomy. On the contrary, early tracheotomy separates patients from respirators more easily and efficiently, reduces the use of sedatives, and makes the tracheobronchial tree hygiene easier and better [6, 17].

Types of tracheotomy (open or percutaneous)

In the Clinical Hospital Center “Dr. Dragiša Mišović Dedinje”, according to the possibilities and experience, the team of doctors gives preference to classical surgical tracheotomy versus percutaneous dilatation tracheotomy, due to safety and simplicity of procedure, avoiding possible complications and shortening the time necessary to perform tracheotomy. Other authors also prefer the open technique [4–6], without diminishing the possibility of applying percutaneous dilatation tracheotomy [14, 15].

Bjork flap tracheotomy

The Bjork flap tracheotomy technique means that the anterior wall of the trachea is sutured to the skin, so it is considered safer for all other manipulations around the tracheal cannula and manipulation with it. Aspiration through the cannula is usually done by nurses in ICU, and in case of necessary faster replacement of the tracheal cannula, an extremely simple and safe way is provided. Bjork flap is found in all guidelines on tracheotomies in COVID-19 patients [1, 3, 10, 12].

Use of electrocautery

There is controversy about the use of electrocautery during tracheotomy in COVID 19-positive pa-

tients. Only 6 guidelines are currently discussing this issue. The recommendation of 5 guidelines is the use of cold dissection and the use of sutures for hemostasis, and only 1 recommends the minimum use of electrocautery [3–7]. We used an electrocautery during the surgery and we believe that with the use of an adequate powerful aspirator it is possible to use an electric knife for tracheotomy.

Tracheal cannula replacement time

The average time for tracheal cannula replacement was on the 10th day (+/- 3 days), which again depends on each patient individually, depending on the local hygiene and care of the tracheobronchial tree, as well as the general condition of the patient.

Conclusion

Although the severe acute respiratory syndrome coronavirus-2 pandemic is still ongoing, many researchers are working to find an adequate treatment modality for coronavirus disease 2019-positive patients.

1. Tracheotomy has a significant place in the treatment of patients with severe coronavirus disease 2019;
2. Tracheotomy has an important place in the treatment of patients with severe coronavirus disease 2019 infection since it provides easier maintenance of the airway, and in the recovery phase leads to easier transition of patients from mechanical ventilation to spontaneous breathing;
3. The decision on the day when a tracheotomy will be performed is strictly individual and depends on the general condition of the patient;
4. The use of thermocautery does not affect the course of treatment and the final outcome of the treatment.

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