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Uncommon presentation of gasping during ventricular fibrillation – case report

Knor J.[1, 2], Pekara J.[2], Málek J.[3, 4]

[1]Zdravotnická záchranná služba Pardubického kraje, p. o., Pardubice
[2]Vysoká škola zdravotnická v Praze, o. p. s.
[3]3. lékařská fakulta, Univerzita Karlova v Praze
[4]Klinika anesteziologie a resuscitace 3. LF UK a FNKV, Praha

Gasping is supposed to be easily recognisable sign of cardiac arrest by typical breathing pattern. We present a 56-year-old man with out-of-hospital cardiac arrest with atypical gasping. Cardiopulmonary resuscitation was started by a lay rescuer using telephone-assisted CPR. On arrival of the rescue team, the patient was gasping with typical inspiration/expiration ratio at high frequency 24/min. Ventricular fibrillation was detected. The first defibrillation shock (200 J) resulted in return of spontaneous circulation. The patient continued with abnormal breathing pattern on a Venti-mask with oxygen supply 8 l/min. After next 2 minutes, ventricular fibrillation returned. A second defibrillation shock (200 J) was performed without ROSC. A third defibrillation shock (200 J) was delivered after 2 minutes with continuing chest compressions and high frequency gasping resulting in definitive ROSC. After ROSC, the patient´s BP was 102/83 mmHg, pulse 124/min, SpO_2 100% using a Venti-mask with an 8 l/min oxygen flow. The total time from OHCA to ROSC was 12 minutes. Fentanyl 0,1 mg was administered i.v. The patient had abnormal breathing pattern with high frequency for several minutes after ROSC, then the pattern returned to normal inspiration: expiration ratio with frequency 18/min. Complete amnesia on the event lasted 3 hours. Based on the literature review, we must conclude that there are insufficient data to recommend when to leave gasping as the sole mode of ventilation during resuscitation in patients with cardiac arrest. This case report describes an abnormal agonal breathing pattern during CPR.

Key words: out-of-hospital cardiac arrest, cardiopulmonary resuscitation, gasping, ventricular fibrillation, recovery of spontaneous circulation.

Neobvyklá prezentace gaspingu u komorové fibrilace – kazuistika

Předpokládá se, že gasping je snadno rozpoznatelným příznakem srdeční zástavy. Náš článek představuje případ 56letého muže s mimonemocniční srdeční zástavou s atypickým lapáním po dechu. Kardiopulmonální resuscitaci zahájil laický zachránce pomocí telefonicky asistované neodkladné resuscitace. Při příjezdu záchranného týmu měl pacient gasping s vysokou dechovou frekvencí 24/min. Iniciální analýza rytmu zjistila fibrilaci komor. První defibrilační výboj (200 J) vedl k návratu spontánního oběhu. Pacient pokračoval s abnormálním dechovým vzorcem na kyslíkové masce s přívodem kyslíku 8 l/min. Po dalších 2 minutách došlo opět ke komorové fibrilaci. Byl proveden druhý defibrilační výboj (200 J) bez ROSC. Třetí defibrilační výboj (200 J) byl proveden po 2 minutách s pokračujícími kompresemi hrudníku a vysokofrekvenčním dýcháním, což vedlo k definitivní defibrilaci s ROSC. Pacientovi byl naměřen tlak 102/83 mmHg, naměřen puls 124/min, SpO_2 byla 100 % při použití masky Venti s průtokem kyslíku 8 l/min. Celková doba od OHCA do ROSC byla 12 minut. Jako analgezie byl podán Fentanyl 0,1 mg i. v. Pacient měl abnormální dýchání s vysokou frekvencí po dobu několika minut po ROSC, poté se vrátil k normálnímu poměru nádechů a výdechů s frekvencí 18/min. Úplná amnézie na událost trvala 3 hodiny. Na základě přehledu literatury musíme konstatovat, že není k dispozici dostatek údajů pro doporučení, kdy ponechat gasping jako jediný způsob ventilace během resuscitace.

Klíčová slova: mimonemocniční srdeční zástava, kardiopulmonální resuscitace, gasping, fibrilace komor, obnovení spontánního oběhu.

KORESPONDENČNÍ ADRESA AUTORA:
Mgr. Jaroslav Pekara, Ph.D., pekara@vszdrav.cz

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Introduction

In the period immediately after cardiac arrest, there is a gradual arrest of spontaneous breathing activity within seconds to minutes followed by a period of agonal or terminal breathing or gasping in some patients. Gasping is associated with probability of a shockable cardiac rhythm during cardiac arrest and might result in better neurological one-year survival, higher rates of sustained ROSC and long-term survival compared to patients without any breathing activity [1–3]. Gasping is supposed to be easily recognisable sign of cardiac arrest by typical breathing pattern with very short inspiration and long expiration pause and dispatchers are trained to recognize cardiac arrest in spite of gasping. However, as stated in the ERC Guidelines 2021, gasping may be in fact often misinterpreted as normal breathing, i.e. a sign of life, which poses a problem for both lay people and healthcare professionals. Gasping, especially if it has a high frequency and relatively high tidal volumes, may remain a barrier to recognise out-of-hospital cardiac arrest (OHCA).We describe such an untypical cause of respiration after cardiac arrest, which was further confirmed by ECG as ventricular fibrillation.

Case Report

After emergency call from a layman, an Emergency Medical System (EMS) dispatcher evaluated situation as a cardiac arrest with gasping and telephone-assisted cardiopulmonary resuscitation (TA-CPR) was initiated. The patient's son, a 30-year-old man, performed chest compressions without artificial ventilation. EMS team with the physician arrived 6 minutes after the emergency call. The patient, a 56-year-old male, had on arrival of EMS team diagnosed cardiac arrest (OHCA) and the primary ECG revealed VF. The patient was gasping, having deep breaths with significantly longer post-expiratory pauses at a high rate of 24/min. The EMS team took over chest compressions, and immediately after the cardiac rhythm was evaluated, a defibrillation shock (200 J) was delivered, resulting in ROSC (Figures 1 and 2). The patient continued with abnormal breathing pattern on a Venti face- mask with oxygen supply 8 l/min and SpO_2 100%. A peripheral venous catheter was inserted in his right forearm, and amiodarone 300 mg was administered. The patient had non-specific response to pain stimulation (Glasgow Coma Score 7) and within the next 2 minutes after ROSC, ventricular fibrillation returned. Second defibrillation shock (200 J) was performed, but did not result in ROSC (Fig. 3). After next 2 minutes, with continuing chest compressions and gasping with the same pattern as in the beginning, a third defibrillation shock (200 J) was delivered, leading to definitive ROSC (Fig. 4). Another dose of amiodarone 150 mg in a continuous infusion was administered. The total time interval from OHCA to ROSC was 12 minutes. After successful ROSC, the patient had the following circulatory parameters: blood pressure 102/83 mmHg, pulse 124/min, SpO_2 remained 100% with spontaneous ventilation using a Venti-mask with oxygen flow 8 l/min. The patient had still breathing pattern inspiration to expiration 1 : 3 and gasping-like face and chest movement, but gained consciousness and started to complain on dyspnoea and chest pain. During resuscitation we repeatedly solved the dilemma whether to transfer the patient to artificial pulmonary ventilation or to keep him on gasping. We did not find factors leading to a clear-cut solution, and the advantages and disadvantages of each solution are given in the discussion below. In the end, the opinion not to start artificial pulmonary ventilation prevailed, although it was not an easy decision. He was administered fentanyl 0.1 mg i. v. in two increments and a normal breathing pattern returned gradually in approximately 5 min. Before transfer to a hospital, a 12-lead ECG was recorded (Figure 5) and acute anterior myocardial infarction (AMI) was diagnosed. The patient was referred to a coronary ICU for coronary intervention (PCI). Laboratory tests on admission confirmed adequate oxygenation (arterial pO_2 19.07 kPa), alkalemia (pH 7.564) with hypocapnia (pCO2 2.49 kPa) and lactate 5.7 mmol/l. Subsequent selective coronary angiography revealed no significant lesion of the coronary arteries. The patient had after previous aortic valve replacement, currently with significant regurgitation. His left ventricular ejection fraction (LVEF) was 55%. The patient was implanted a cardioverter (BiV ICD) and was discharged after 4 days of hospitalization without any neurological deficit. In spite of verbal contact during transport, he had complete amnesia for the entire duration of all procedures including the first 2 hours of hospitalization.

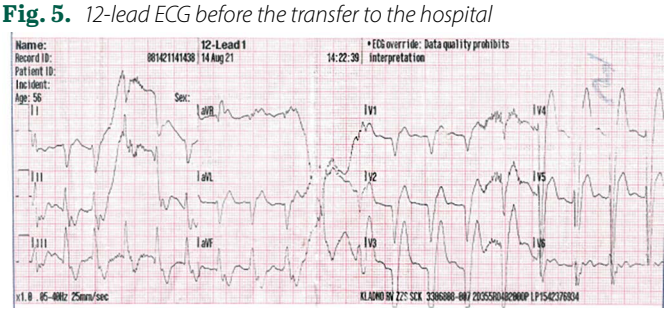
Fig. 1. *Initial ECG rhythm*

Fig. 2. *ECG rhythm after the first defibrillation shock*

Fig. 3. *ECG rhythm after the second defibrillation shock*

Fig. 4. *ECG rhythm after the a third defibrillation shock*

Fig. 5. *12-lead ECG before the transfer to the hospital*



Discussion

We present a very abnormal agonal breathing during cardiac arrest and post-resuscitation period. This case opens questions when to start

artificial ventilation and when to administer drugs to suppress spontaneous ventilation in case of apparently normal SpO_2 during gasping. Gasping is a well-known phenomenon occurring after cardiac arrest. It is reported in 33 to 60% of all OHCA patients and is common during the first minute in patients with ventricular fibrillation [1–3]. There is ample literature on the positive relationship between the presence of gasping and the probability of successful survival without neurological sequelae; on the other hand, there is remarkably little literature defining gasping and its difference from eupnoea. In the available literature, the main difference is described as a change in breathing pattern: very rapid inspiration followed by prolonged expiration. Ramirez and Lieske in their publication report the absence of expiratory activity and lack of involvement of expiratory muscles in breathing pattern as another characteristic feature of gasping [4]. The transition between normal respiration and gasping may not always be clear; pre-gasping activity - the transition between eupnoea and gasping similar to our case except of high frequency has also been described [4]. There are large differences concerning effective volume of gas exchange during gasping. Wolfskeil measured tidal volumes achieved by gasping and the average volume was about 350 ml with a wide range of 52-1280 ml [5]. Finally, scientific information regarding the frequency of gasping is completely missing. Only vague data can be found on the mostly slower frequency of agonal breathing compared to normal breathing, which slows down further over time until it spontaneously disappears or reappears when chest compressions are initiated.

In this case report, an unusual rapid frequency of gasping (24 breaths per minute) was observed. In our patient, gasping with unobstructed airways during CPR had an unquestionable positive effect on maintaining adequate oxygenation (SpO_2 was 100% with oxygen flow 8 l/min) even without artificial pulmonary ventilation (APV). The duration of gasping was prolonged to a full 12 minutes during CPR until ROSC, partly also because of good quality of chest compressions, and probably even several minutes after ROSC. It confirms the previous report that transition between normal respiration and gasping may not always be clear [4]. The different pressure ratios in the chest during spontaneous gasping and artificial ventilation with intermitent pressure with intermittent pressure should also be taken into account. The literature comparing, for example, active compression-decompression resuscitation and impedance threshold device for out-of-hospital cardiac arrest does not give clear results either [2]. Thus, our decision was based primarily on the clinical condition of the patient. Because of apparently good effect of gasping on oxygenation we decided not to start 30:2 compression-to-ventilation ratio recommended in ERC guidelines. The reason for this decision were published data mainly from animal experiments, that compared to APV gasping has several beneficial effects on circulation and brain functions. Gasping produces negative intrathoracic pressure and generates a pressure gradient between right heart and large vessels that promotes venous return. Minor increasing of intrathoracic pressure during expiratory phase potentiates aortic pressure. Gasping-induced changes in circulation improves coronary perfusion, but also brain circulation. Similar changes can be observed in humans using active compression-active decompression device [6]. Moreover, strenuous gasping would interfere with APV and general anaesthesia would be necessary.

The question remains as to whether gasping can be used in some cases as the only ventilation during chest compression without following the standard 30:2 compression-to-ventilation ratio recommendation (so-called "hands only CPR"). We found only three similar reports. Bunya et al. described a successful resuscitation of a man with asystole but with preserved breathing (no other data concerning ventilation are available) [7]. In their second publication, they mentioned a transport of patients after OHCA with continuous chest compression and gasping only to a hospital with good survival rate, but again without more detailed information concerning agonal breathing. [8] An extreme duration of gasping – 67 minutes – in a patient with ventricular fibrillation was reported by Okamoto et al. [9]. Gasping was preserved all the time during transport, repeated defibrillation and connecting to ECMO. Patient survived. The second patient of Okamato et al. was also treated by ECMO and had preserved gasping, but no information concerning its duration was described. Here we come to the next question, namely whether we should perform early advanced airway management (e.g. tracheal intubation and artificial lung ventilation) or prefer gasping during extended CPR in patients with gasping. The differences in available literature and lack of sufficient data does not allow us to give a clear answer. On the one hand, there are data from animal studies of beneficial effect of gasping on brain circulation and cardiac output compared to APV [6]. On the other hand, artificial pulmonary ventilation eliminates the patient's breathing effort and may reduce lactic acidosis in tissues. The results of the acid-base balance examination indicated that the body made a maximal effort to compensate for metabolic acidosis by hyperventilation, suggesting that the patient had a preserved respiratory response to the low pH even during cardiac arrest and resuscitation. We can only speculate whether elimination of oxygen consumption using muscle relaxation would have led to a better outcome. Next benefit of the use of general anaesthesia with advanced airway strategy is our concern that the patient might perceive subjectively unpleasant and painful procedures during CPR (mainly chest compressions and defibrillation) as well as risk of regurgitation and aspiration. On the other hand, cardio-depressive effect of anaesthetics and muscle relaxants and well-known risk of failed tracheal intubation may result in unfavourable result [10]. Surprisingly, even large-scale studies do not give a clear answer. The latest European Resuscitation Council guidelines stated that: "Advanced life support providers should initiate artificial ventilation as soon as possible in any patient in whom spontaneous ventilation is inadequate or absent" [10]. Does this mean that in some cases of gasping with apparently large gas exchange volumes and high rates, where patients' respiratory effort prevents manual face and bag breathing, oxygen administration alone is sufficient? In our opinion, it is necessary to proceed individually in atypical situations using all clinical knowledge.

Conclusion

In this case report, we described an abnormal agonal breathing pattern during CPR in a patient with ventricular fibrillation and demonstrated that in some cases gasping may be effective as a single method of

ventilation during CPR. Based on the literature search, we must conclude that there are insufficient data to recommend when to leave gasping as the only mode of ventilation during resuscitation in patients with cardiac arrest and when to use standard CPR using a 30:2 ratio of chest compressions and artificial ventilation with possible use of anaesthetics and muscle relaxants.

AUTHOR DECLARATION: **Declaration of authenticity:** The authors declare that the manuscript is original and was not published or sent for publication in another journal. **Conflict of interest:** The authors have no conflicts of interest to declare. **Ethical considerations:** The study was approved by Medical College in Prague Institutional Review Board with a waiver of informed consent owing to its retrospective nature (IRB No. 1103-153-357). The first approval date was August 15th, 2022. The patient consented with the publication. **Acknowledgements:** N/A. **Funding:** N/A.

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