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Anaphylactic shock causing cardiac arrhythmia: A case analysis of successful precordial thump intervention

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Abstract: This article presents a clinical case analysis of cardiac arrhythmia induced by anaphylactic shock, along with the diagnosis and treatment methods employed in the case. The article provides a detailed explanation of the causes and mechanisms of allergic reactions caused by neuromuscular blocking agents and the subsequent cardiac arrhythmias. It also discusses treatment methods such as precordial thump. This article can serve as a reference for clinicians dealing with similar cases.

Keywords: Allergic Shock; Arrhythmias; Case Analysis

1. Background Introduction

The frequency of systemic allergic reactions during anesthesia varies according to studies, ranging from 1/1250 to 1/18600[1-7]. Among them, neuromuscular blocking agents (NMBAs) have been reported as the main cause of most perioperative allergic reactions[8, 9]. Approximately 50% of systemic allergic reactions in adults during the perioperative period are detected through early symptoms such as hypotension, circulatory failure, and cardiac arrest[10]. A study in France reported that 72.9% of severe drug-induced systemic allergic reactions can be confirmed through skin testing [11].

2. Clinical Case

A 20-year-old male patient with a weight of 100kg was admitted to the hospital due to “right ear pain with decreased hearing for more than 3 years.” He has a history of sinusitis and seafood allergy (symptoms include skin rash on the hands and mild itching), but no other significant medical history. Preoperative examination revealed abnormal blood glucose and creatine kinase levels (glucose: 6.31mmol/L, creatine kinase: 354IU/L). The electrocardiogram showed sinus rhythm. No other specific abnormalities were found in the examination. The patient was classified as ASA Grade II. Microscopic surgery was performed on the right ear after admission. Prior to anesthesia induction, the patient was conscious and provided coherent responses. The drugs used for induction included Penehyclidine Hydrochloride Injection 0.5mg, Midazolam Injection 2mg, Sufentanil Citrate 25ug, Cisatracurium Besilate 14mg, and Propofol 100mg. During anesthesia induction, the patient experienced severe shock and subsequently developed ventricular arrhythmia (initially premature ventricular contractions, rapidly transitioning to ventricular tachycardia). Non-invasive blood pressure measurement was unsuccessful. Based on the temporal relationship between symptom onset and injection, it was diagnosed as anaphylactic shock caused by anesthesia induction drugs, as well as arrhythmia triggered by anaphylactic shock. The medical staff immediately administered precordial thumps to the patient, and the patient recovered sinus rhythm. Subsequently, Adrenaline Hydrochloride Injection 200ug, Methylprednisolone 40mg, and Calcium Gluconate Injection 1g were administered, and fluid infusion was expedited to treat anaphylactic shock. Simultaneously, rapid endotracheal intubation and mechanical ventilation were performed. A new venous access was established to administer Norepinephrine at a rate of 5ug/kg/min to maintain blood pressure. With timely rescue measures, the patient’s vital signs gradually improved. Following the goal of maintaining systolic blood pressure above 90mmHg, vasoactive drugs were dynamically adjusted. After communicating the condition with the patient’s family, they requested to proceed with the surgery. The surgical procedure proceeded smoothly, and with close monitoring and appropriate medication adjustments, the patient’s vital signs remained relatively stable. Postoperatively, the patient still required a significant amount of vasoactive drugs to maintain vital signs. After thorough discussions and communication with the patient and their family, the decision was made to transfer the patient to the ICU for further treatment. The following day, the patient’s condition improved. Cardiac echocardiography showed normal lower limits of left ventricular systolic function. Electrocardiogram revealed sinus bradycardia with arrhythmia, and “J” point elevation was observed in

leads V3-V6. The patient was discharged upon recovery. During the follow-up period, the patient did not experience any significant discomfort. After discharge, an allergy test conducted outside the hospital revealed a possible allergy to neuromuscular blocking agents (Table 1, Table 2, Table 3).

Table 1

Skin Prick Test,SPT				
Drug Name	Concentration of Stock Solution	Concentration for Skin Prick Test	Wheal Size	Result
NMBAs				
Rocuronium Bromide	10mg/ml	5mg/ml(1:2)		(−)
vecuronium bromide	4mg/ml	0.4mg/ml(1:10)		(−)
Cisatracurium Besilate	2mg/ml	2mg/ml(stock solution)		(−)
sedative-hypnotic				
Midazolam	5mg/ml	5mg/ml(stock solution)		(−)
Propofol	10mg/ml	1mg/ml(1:10)		(−)
opioid drug				
Fentanyl	50ug/ml	50ug/ml(stock solution)		(−)
Remifentanil	50ug/ml	50ug/ml(stock solution)		(−)
Sufentanil	5ug/ml	5ug/ml(stock solution)		(−)
Others				
Chlorhexidine	5mg/ml	5mg/ml(stock solution)		(−)
Cefazolin	20mg/ml	20mg/ml		(−)

Table 2

Intradermal Test,IDT			
Drug Name	Result recorded		
NMBAs	1:10000	1:1000	1:100
Rocuronium Bromide	/	(−)	
vecuronium bromide	(−)	(±)	
Cisatracurium Besilate	(−)	(−)	(±)
sedative-hypnotic	1:1000	1:100	1:10
Midazolam	(−)	(−)	(−)
Propofol	(−)	(−)	(−)
opioid drug	1:1000	1:100	1:10
Fentanyl	/	(−)	(−)
Remifentanil	(−)	(−)	(−)
Sufentanil	(−)	(−)	(−)
Others	1:1000	1:100	1:10
Chlorhexidine	/	/	(−)
Cefazolin	(−)	/	/
conclusion	Based on the patient's previous anesthesia records, intradermal tests were conducted using vecuronium bromide, cisatracurium besilate, midazolam, propofol, sufentanil, and remifentanil. Among them, intradermal tests with cisatracurium besilate and vecuronium bromide showed suspicious positive reactions. Further cross-reactivity testing was performed, and the intradermal test with rocuronium bromide was negative. Based on previous experience, the primary allergen causing severe perioperative allergic reactions is neuromuscular blocking agents. It is recommended to avoid the use of cisatracurium besilate and vecuronium bromide in the future and consider using rocuronium bromide as an alternative. Enhanced monitoring during the surgery is still necessary.		

Table 3

provocation test			
Test drug: cefazolin		Route of administration: Intravenous (IV)	
Dosage:	50mg	200mg	250mg
Administration time	09:40	10:25	11:00
confirmation time	10:15	10:55	11:55
rash	none	none	none
peak flow rate	650	650	650
Heart rate	80	76	72
Blood oxygen saturation	98%	98%	97%
Blood pressure	110/70	109/67	116/77
Respiratory rate	20	19	19
Result	The result of the skin test and provocation test for cefazolin was negative, indicating that the patient is not allergic to cefazolin.		

3. Diagnosis and treatment

Based on the patient's medical history, clinical presentation, and relevant test results, it was initially suspected that the patient may have an allergic reaction to certain anesthetic drugs. The allergic reaction occurred rapidly and developed rapidly, with severe symptoms (rash/shock/arrhythmia), requiring continuous epinephrine infusion during the anesthetic surgery. The clinical presentation met the diagnostic criteria for allergic reactions and refractory allergic reactions [12, 13]. In order to further confirm the diagnosis, the patient underwent intradermal tests with cis-atricurium and vecuronium according to our recommendation, and the results showed that the patient had a suspected positive reaction. In response to the patient's ventricular tachycardia, we immediately performed precordial thump therapy, effectively restoring the patient's sinus rhythm.

4. Discussion

4.1 Causes of anaphylactic shock

During anesthesia surgery, the drugs that the patient has been exposed to are: Penehyclidine Hydrochloride Injection, Midazolam, Propofol, Sufentanil Citrate, Cisatracurium Besylate, and Cefozolin. The relevant drug stimulation test and skin prick test (SPT) conducted by the patient after surgery did not report positive results, while the intradermal test (IDT) indicated suspicious positivity of vecuronium and cisatracurium. Among them, no relevant experiments have been conducted on Penehyclidine Hydrochloride Injection, and there have been almost no reports of allergies related to it. Therefore, we can temporarily assume that the possibility of allergies to Penehyclidine Hydrochloride is extremely low, while there is a higher possibility of allergy to neuromuscular blocking agents.

4.2 Allergic reactions and anaphylactic shock caused by neuromuscular blocking agents

In recent years, the frequency of allergic reactions during anesthesia has been reported to be increasing in most developed countries [9, 14], and neuromuscular blocking agents (NMBAs) have been identified as the main cause of most perioperative allergic reactions [8, 9]. Furthermore, they are responsible for 80% of cases of anaphylactic shock occurring in patients after anesthesia [9, 15]. Allergic reactions caused by NMBAs can be classified into type I hypersensitivity reactions and non-specific hypersensitivity reactions [9, 16-18].

The main mechanism of hypersensitivity reactions caused by NMBAs is acute type I allergic reactions, accounting for 50-70% of such reactions during anesthesia [16-18]. NMBAs can also induce degranulation of mast cells and release of allergic mediators by activating MRGPRX2, a receptor that can activate mast cells and cause non-specific hypersensitivity reactions. Approximately half of the non-specific hypersensitivity reactions during the perioperative period are attributed to NMBAs [9].

As specific IgE level testing was not performed, the specific type of NMBA allergy in this patient was not clearly identified.

4.3 Causes of arrhythmia

We believe that the patient's arrhythmia was triggered by an allergic reaction. Allergic reactions can cause any type of arrhythmia [19], but possible mechanisms include arrhythmias caused by decreased cardiac perfusion due to anaphylactic shock and abnormal contraction function, rhythm, and coronary artery tension caused by chemical mediators released during the allergic reaction period [20].

4.4 Precordial thump,PT

PT is undoubtedly a simple and feasible treatment method when it is necessary to restore organized cardiac electrical activity and transform patients from ventricular tachycardia to a more stable and organized rhythm. It uses appropriate force to hammer the surface precordial area of the body, causing the resulting shock to oscillate in the arrhythmic heart. Under the mechanical electrical feedback, the myocardium undergoes depolarization, which may be the reason why PT can effectively terminate the patient's ventricular arrhythmia. For patients with cardiac instability who cannot be immediately defibrillated, PT can be the first choice [21]. Sometimes in patients with ventricular tachycardia, a single chest blow can lead to a transition to sinus tachycardia [22]. This method is relatively safe [23], and in specific hospitalization and monitoring environments, hammering stimulation can be attempted for patients at the onset of potentially fatal arrhythmias. In this case, PT was successfully used to rapidly convert ventricular tachycardia into sinus tachycardia, which saved the patient the shortest possible time to recover effective circulation. But there are also opinions that in the process of cardiopulmonary resuscitation such as cardiac arrest and ventricular fibrillation, these alternative techniques cannot delay standard CPR measures [22, 24, 25].

5. Conclusion

In this case, the patient may have experienced an allergic reaction and arrhythmia due to an allergy to neuromuscular blocking agents. During treatment, continuous infusion of epinephrine through a pump and precordial thump (PT) were both effective. It is important to note that allergic reactions can cause various types of arrhythmias, and prompt measures should be taken. Additionally, precordial thump can be the first choice when defibrillation is not immediately available for unstable cardiac patients. Although this method is simple and feasible, clinicians should possess basic skills in ECG analysis and identifying different types of arrhythmias. Furthermore, during the treatment, attention should be given to the force and the precise location of the precordial thump to avoid causing secondary harm to the patient. Precordial thump is a safe and effective treatment method, but it should be used with caution and under the guidance of medical professionals.

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