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Spontaneous pulmonary air embolism in a child undergoing procedural deep sedation: case report and review of the literature

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Abstract. – We performed a systematic review of the literature starting from a real case of venous air embolism (VAE) in a young infant undergoing central catheterization during procedural sedation. Air embolism due to internal jugular vein catheterization during procedural sedation is very rare, but it is a potentially life-threatening complication of central catheterization that warrants attention. To our knowledge, this is the first case published in a similar scenario.

Key Words:
Children, Pulmonary embolism, Air embolism, Deep vein thrombosis, Deep sedation.

Introduction

We performed a systematic review of the literature starting from a real case of venous air embolism (VAE) in a young infant undergoing central catheterization during procedural sedation. Air embolism due to internal jugular vein catheterization during procedural sedation is very rare, but it is a potentially life-threatening complication of central catheterization that warrants attention. To our knowledge, this is the first case published in a similar scenario.

Case Report

The patient was a 4 months old female infant with a suspected genetic syndrome (cleft palate, inter-atrial defect, and cervicodorsal spine abnormalities) associated with episodes of hyperthermia giving a clinical suspicion of Crisponi or Stuve-Wiedemann syndrome (genetic studies ongoing). At birth, she underwent hypothermia and was admitted to the Neonatal Intensive Care Unit for meconium aspiration syndrome. The patient was subjected to intestinal resection with ileostomy packaging and recanalization with terminal-terminal anastomosis after around 45 days. Since post-surgical re-feeding, she presented constantly liquid stools and extremely poor growth rate. For this reason, it was decided to place a central venous access in order to be able to sustain the patient with a proper nutritional support. The procedure was performed in the "sedation room" located in a dedicated area of the Pediatric Intensive Care Unit of our Institution. The patient was monitored according to standard procedures, sedated with midazolam and left in spontaneous breathing using Sevoflurane. With ultrasound-guided technique, the internal jugular vein (IJV) was located and inserted using a 22 Gauge needle. At the time of the guide's insertion, the girl performed a vigorous breath allowing the passage of air in IJV. Immediately, the patient presented bradycardia that rapidly evolved to asystolia. The girl was then cardio-pulmonary resuscitated (bag-valve mask hand ventilated and cardiac massage) for two minutes, with complete recovery of cardiac activity and no sequelae. Blood tests showed raised troponin and lactate levels with dyselectrolytemia that necessitated of fluid corrections, achieving normalization of electrolytes, troponin, and lactate in 24 hours. Chest X-Ray showed a partial opacity of left lung soon after the insertion of the catheter (Figure 1).

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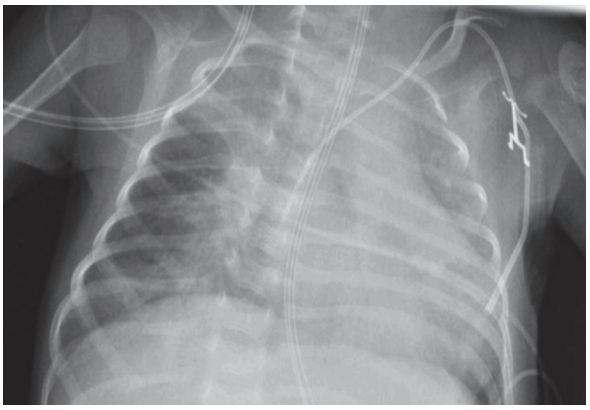

Figure 1. Chest X-Ray showed a partial opacity of left lung soon after the insertion of the catheter.

Introduction on Pulmonary Embolism

Pulmonary embolism (PE) in children differs in terms of incidence, predisposition, pathophysiology, presenting symptoms, and management strategies. PE is believed to be a rare event in children[1,2]. However, the incidence of PE in children has been steadily increasing, which can be attributed to numerous factors, including increased awareness and recognition, increased survival of children with underlying predisposing conditions, increased use of central venous catheters (CVCs) in infants and neonates, and the availability of noninvasive diagnostic modalities[3,4]. The early incidence estimates of PE stem from autopsy studies[5-7] and report an incidence of 0.05% to 4.2%. The variability in the incidence of various registries may again reflect the limitations of diagnosing PE in an effective manner. Besides reporting the incidence, registry reports highlight important characteristics of PE in children. Researches[2,8] report an incidence of 8.6 to 57 per 100,000 in hospitalized children, whereas the incidence in all children in the community is estimated to be 0.14 to 0.9 per 100,000. PE shows a bimodal distribution in children; a higher incidence is reported in infants (younger than the age of 1 year) and in teenagers[1-4]. This bimodal pattern of distribution can be attributed to increased utilization of CVCs in the neonate and infant age group, whereas pregnancy and use of hormonal contraceptive methods account for the higher incidence among female adolescents. A recent systematic review of the literature on pediatric PE describes 2 distinct variants of PE in children: *in situ* pulmonary artery thrombosis (ISPAT) and classic thromboembolic PE. Each category differs in underlying etiologic factors, long-term management, and outcomes. ISPAT usually occurs in younger children with congenital heart disease or anomalies of pulmonary arteries. Similarly, classic thromboembolic PE is correlated with underlying risk factors. The classic triad of PE symptoms consists of pleuritic chest pain, shortness of breath and hemoptysis, and is common to both adults and children. However, the diagnosis of PE can be missed in children, as seen in autopsy studies, or delayed, as reported by Rajpurkar et al[7] when the time to PE diagnosis is made at an average of 7 days (range 1-21 days) after the onset of symptoms. Numerous factors contribute to this delay. Symptoms of PE are nonspecific and can mimic other childhood conditions, such as pneumonia, atelectasis, and thoracic tumors[9]. Furthermore, unexplained persistent tachypnea can be an important indication of PE in pediatric patients of all age categories[10]. Additional signs and symptoms include cough, fever, hemoptysis, tachycardia, hypoxemia, and chest pain[11-13]. Massive PE as defined by an embolus sufficient to cause obstruction of the pulmonary flow, resulting in hemodynamic instability, is considered a rare event in children and is associated with a high mortality of greater than 50%[14]. Presenting symptoms include hypotension, dyspnea, hypoxemia, syncope, right-sided ventricular failure, and it can occasionally present with sudden death[15]. Interestingly, air embolism is even less described in children compared with classic PE. We report a case of pulmonary air embolism in a child undergoing a deep sedation to insert a central venous catheter in our sedation room.

Discussion

We described a case of venous air embolism (VAE) in a young infant undergoing central catheterization during procedural sedation. Air embolism due to IJV catheterization during procedural sedation is rare, but it is a potentially life-threatening complication of central catheterization that warrants attention. To our knowledge, this is the first case published in a similar scenario. The term embolism identifies any presence in the blood vessels of a mobile body unable to dissolve in the blood. This body, generically called an embolus, can be a blood clot, a lump of fat, an air bubble, and so on. The emboli are transported from the blood to a point where they stop partially or totally blocking the blood circulation. The air bubbles, therefore, have all

the typical characteristics of the emboli; consequently, moving within the vascular system, they can reach any part of the body and hinder blood circulation. The presence of air bubbles circulating in the vascular system can be very dangerous, as the emboli could reach also the arteries of the brain, the coronaries or the pulmonary vessels. The gaseous bubbles form within the vascular system when the conditions of pressure, around a blood vessel exposed to a gas, favor the entry of the latter into the vessel itself. In other words, if an artery or vein is in contact with the air and the surrounding pressures allow it, atmospheric gases can penetrate into the vessel involved and form bubbles.

The formation of one or more air bubbles within a blood vessel can occur on several occasions. Often and for different reasons, it is necessary to use central venous catheters in a subclavian or jugular vein. Since in these regions the pressure conditions are in favor of the entry of air into the vascular system (venous pressure is lower than atmospheric)[16], the introduction of a catheter could represent a potential access route for atmospheric gases, as happened in our case. The initial sign of air embolism is a sudden change in respiratory parameters, and various cardiopulmonary symptoms and signs are described[17]. In our case, immediately after venipuncture (happening simultaneously with a deep breath), the infant developed progressive bradycardia up to asystolia which required cardiopulmonary resuscitation (CPR). Since the procedure was on spontaneous breathing, end-tidal CO_2 (which is reduced in case of embolism) could not be measured and registered, and the need of prompt intervention allowed us to perform diagnostics only when CPR was concluded. Anyway, the anesthesiologist considered the possibility of an air embolism because these changes occurred soon after air injection and recovered after O_2 administration and CPR. The VAE is mainly described in children undergoing cardiac surgery[18,19], neurosurgery[20], orthopedic procedures[16] or any procedure involving central veins such as vena cava (21), but never in situations similar to our scenario. The incidence of VAE in considered to be lower in pediatric patients than adults[22,23]. VAE can potentially occur in any procedure where the surgical site is above the level of heart creating a negative pressure gradient to right atrium and air get sucked; in our case, the infant was laying in a horizontal position; therefore, the puncture point was in the same level of the heart, but both the negative pressure created by the inspiration and the right atrium dilatation during the "filling phase" probably allowed the strong negative pressure and air entrance. Although children are less prone to venous air embolism than adults, they are more susceptible to the adverse effects of embolization[24]. This incidence, however, is certainly underestimated, since many cases are asymptomatic and often the symptoms are confused with those of the underlying disease. The effects of pulmonary embolism depend on the degree of obstruction of the pulmonary circulation, as well as on the presence of coexisting cardiopulmonary diseases. When the embolism obstructs more than 50% of the pulmonary circulation, the outflow resistance from the right ventricle increases, resulting in increased pressure on the pulmonary artery and dilatation of the right ventricle. The consequence is a tricuspid deficiency. The filling of the left ventricle is also compromised due to the protrusion of the interventricular septum resulting from the increased pressure on the right side of the heart. This can produce systemic hypotension or cardiogenic shock.

Conclusions

Although extremely rare, we think our case should raise awareness of a new potential complication of procedural sedation, reminding all clinicians undergoing these procedures to be always equipped and trained in managing such a potentially severe unexpected complication.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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