Cardiology in the Young

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Re-expansion pulmonary edema after minimally invasive cardiac surgery in children

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Abstract

Re-expansion pulmonary edema is a serious complication that can occur after minimally invasive cardiac surgery through a right mini-thoracotomy. Herein, we describe two paediatric cases where re-expansion pulmonary edema was observed after simple atrial septal defect closure through a right mini-thoracotomy. This is the first case report of re-expansion pulmonary edema after a paediatric cardiac surgery.

Brief Report

Cite this article: Kimura N, Yamashita K, and Shimizu H (2023) Re-expansion pulmonary edema after minimally invasive cardiac surgery in children. *Cardiology in the Young* **33**: 1763–1764. doi: 10.1017/S1047951123000628

Received: 24 February 2023
Revised: 9 March 2023
Accepted: 9 March 2023
First published online: 31 March 2023

Keywords:
CHD; re-expansion pulmonary edema; minimally invasive cardiac surgery

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Re-expansion pulmonary edema is a serious complication that can occur after minimally invasive cardiac surgery through a right mini-thoracotomy with single lung ventilation.[1,2] Recently, minimally invasive cardiac surgery with a small right axillary incision is being routinely performed to repair CHDs,[3] but there are no reports of re-expansion pulmonary edema after minimally invasive cardiac surgery in children so far. Herein, we report two paediatric cases where re-expansion pulmonary edema was observed after minimally invasive cardiac surgery with a small right axillary incision around the same time and describe our current strategy for re-expansion pulmonary edema prevention.

Case report

The two cases involved an asymptomatic 3-year-old girl and 7-year-old boy, who were found to have a heart murmur and an abnormality in the electrocardiogram, respectively, during their routine check-ups. After several examinations, they were diagnosed with large secundum atrial septal defect. Transcatheter device closure was difficult to perform because of the large defect size and rim deficiency. We decided to perform minimally invasive cardiac surgery for ASD closure at the parents' requests.

The patient was intubated and a 4-Fr Fogarty catheter was placed in the right bronchi as a bronchial blocker for single lung ventilation. The surgical technique was similar to what has been previously reported.[3] The operation was completed without any issues, and the ASD was closed with autologous pericardium. The cardiopulmonary bypass time and aortic cross-clamp time were reasonable (51 and 72, and 22 and 26 minutes, respectively). After cardiopulmonary bypass was terminated and the right lung was fully inflated, copious amounts of pink frothy sputum appeared in the endotracheal tube. Cardiac function was preserved with no ASD leakage. Pulmonary veins were normal anatomy with no injury during the procedure. Re-expansion pulmonary edema was suspected when chest radiography showed markedly decreased permeability in the right lung in the first case (Fig 1) and bilateral lungs in the second case (Fig 2). Ventilation with a high positive end-expiratory pressure of 10 cm H_2O was delivered, and the patients' respiratory statuses improved rapidly; they were extubated and discharged on post-operative days 2 and 6, and 16 and 15, respectively, following a generally uneventful post-operative course.

Discussion

The mechanism of re-expansion pulmonary edema development is still unclear. Capillary endothelial injury from lung re-expansion, lung parenchymal injury from systemic inflammatory responses associated with cardiopulmonary bypass, and pulmonary ischaemia-reperfusion injury may all act synergistically and cause re-expansion pulmonary edema after minimally invasive cardiac surgery.[1,2,4] The incidence of re-expansion pulmonary edema after minimally invasive cardiac surgery in adults is approximately 2.1%.[2] However, only a few paediatric re-expansion pulmonary edema cases have been previously reported,[5] and no cases have been reported after a paediatric cardiac surgery. To the best of our knowledge, this is the first case reported.

We have performed minimally invasive cardiac surgery with a small right axillary incision in many children and no re-expansion pulmonary edema happened other than these two cases. We also never experienced re-expansion pulmonary edema after cardiac surgery through a median sternotomy or partial sternotomy. When we retrospectively consider the cause for re-expansion

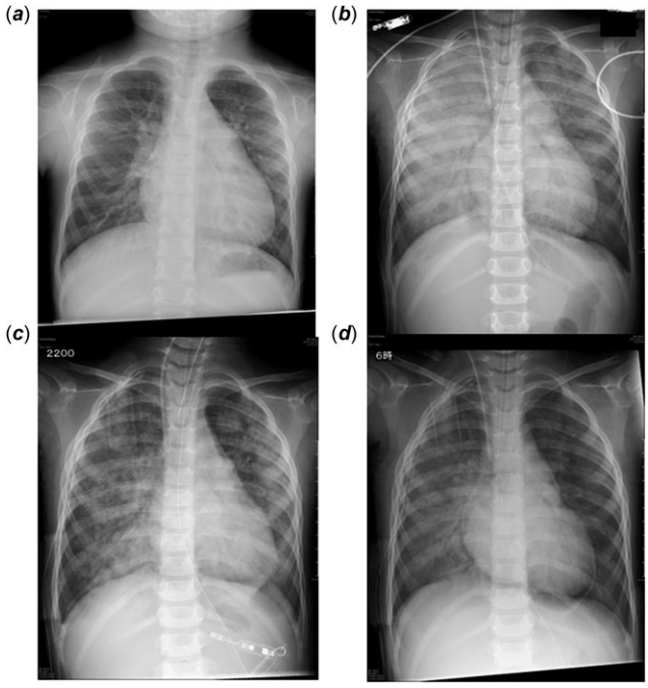

Figure 1. Changes in the chest radiographs of the 3-year-old girl. (***a***) Before (***b***) immediately after (***c***) 8 hours after, and (***d***) 24 hours after surgery.

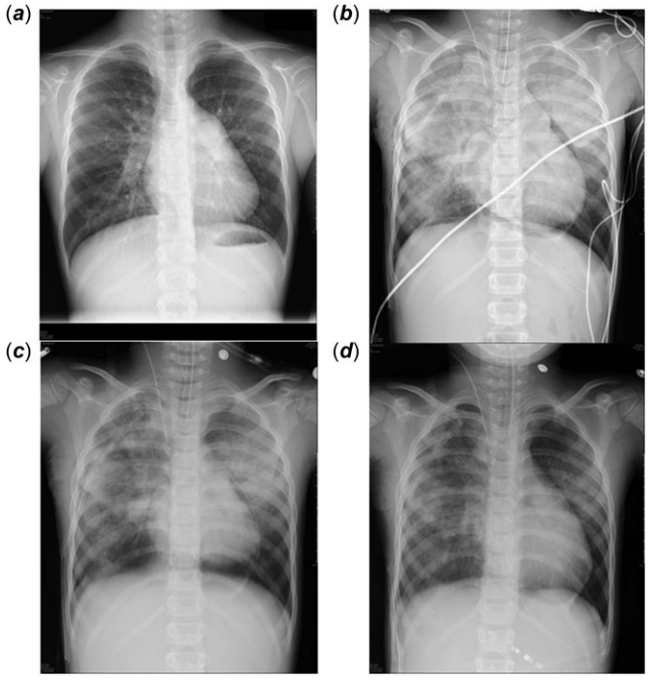

Figure 2. Changes in the chest radiographs of the 7-year-old boy. (***a***) Before (***b***) immediately after (***c***) 4 hours after, and (***d***) 24 hours after surgery.

pulmonary edema, the only possibility that arise is the Fogarty catheter that was used as a bronchial blocker. In these two patients, we used the Fogarty catheter for the first time that could collapse right lung completely. Complete lung collapse with cardiopulmonary bypass may have influenced re-expansion pulmonary edema development. Therefore, it was decided not to adopt the Fogarty catheter and single lung ventilation for subsequent patients. The lungs are ventilated with low ventilation and low positive end-expiratory pressure until cardiopulmonary bypass initiates and once the pericardium is fixed, the lungs do not interfere with the surgical field. No re-expansion pulmonary edema have occurred since then.

Inoue et al. reported that intermittent right lung ventilation, restoration of bilateral ventilation, mannitol administration, and institution of mild hypothermia are effective in re-expansion pulmonary edema prevention.[4] Our results support that various damage due to complete lung collapse is the most important risk factor for re-expansion pulmonary edema development after minimally invasive cardiac surgery. We strongly believe that the lungs should be kept inflated with some degree of positive end-expiratory pressure to prevent re-expansion pulmonary edema. In our cases, fortunately, the lung condition improved rapidly with only ventilator management, possibly due to the shorter lung collapse and aortic cross-clamp times, and less severe lung injury.

In the second case, not only right lung but also left lung, that was intact during the surgery, was damaged on the chest radiography (Fig 2). The frothy sputum was prominent from the right bronchus, but not from the left bronchus by bronchoscopy. From this point of view, we thought that the inflammatory reaction that developed in the right lung developed into a systemic inflammatory reaction that spread to the left lung.

Acknowledgements. None.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Conflict of interest. None.

Ethical standards. The patient's parents provided informed consent for this case report.

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https://doi.org/10.1017/S1047951123000628 Published online by Cambridge University Press