

Diaphragmatic paralysis following open-heart surgery in an adult

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Diaphragmatic paralysis is a rare but severe cardiac surgery complication that causes poor outcomes, including mortality and prolonged ventilation [1]. Although this condition is established in pediatric cardiac surgery [2–4], limited data exist on its occurrence in adults, with a prevalence of 0.8%–6% [5].

We present a 73-year-old woman with an aortic and mitral valve replacement history who underwent aortic prosthetic valve failure surgery and coronary artery bypass grafting. Pre-operative chest radiography was unremarkable (Fig. 1a); postoperative chest radiographs showed right diaphragm elevation (Fig. 1b), suggesting diaphragmatic paralysis. Diaphragmatic nerve paralysis was diagnosed using clinical assessment, radiological findings, and diaphragm ultrasound. Diaphragm ultrasound revealed a 0 mm diaphragmatic excursion, with minimal diaphragm contraction (Fig. 2a and b). On day 3, the patient experienced respiratory failure and required intubation and mechanical ventilation. She was later extubated on day 15, although her self-expectorant ability was reduced. The patient underwent rehabilitation during her intensive care unit stay and was eventually discharged to the general ward. When phrenic nerve conduction testing was performed, no amplitude was observed. When we consulted a neurologist, the opinion was that recovery from phrenic nerve paralysis would be difficult.

Adhesions from previous surgeries may have contributed to the stretching and subsequent diaphragmatic nerve palsy. Patients who underwent multiple open-heart surgeries should be closely monitored for diaphragmatic paralysis, and their respiratory management should consider this complication. Rehabilitation to prevent self-expectorant capacity reduction should be considered. Early diagnosis and management are crucial for optimal patient outcomes. In discussing this case's diaphragmatic dysfunction causes, considering factors that may influence postoperative diaphragmatic nerve palsy prevalence, including reoperation post-open-heart surgery, is important. Some literature has reported phrenic nerve dysfunction using diaphragm echocardiography in patients undergoing cardiovascular surgery [5, 6].

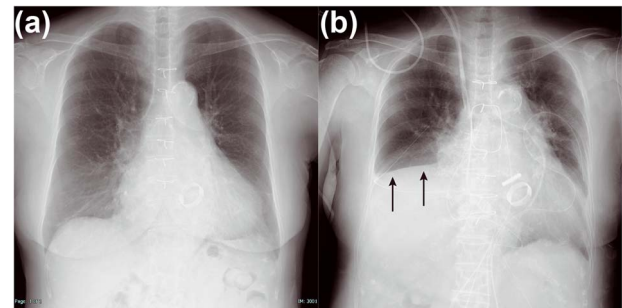


Figure 1. Chest radiographs. (a) Preoperative chest radiograph showing no elevation of the right diaphragm. (b) Chest radiograph on the second postoperative day showing elevation of the right diaphragm (black arrow).

Although reoperation may be a risk factor, further research is needed to better understand diaphragmatic paralysis incidence and risk factors post-open-heart surgery in adults. Because it was difficult to wean the patient from the ventilator due to phrenic nerve paralysis, the patient was transferred to a mechanical ventilation center that specializes in chronic mechanical ventilation management on postoperative day 71. The patient was weaned from the ventilator on postoperative day 99 and is currently being followed up as an outpatient at our hospital.

This case highlights the importance of early diagnosis and management and the need for continued research. Even in cases where it is difficult to wean the patient from a ventilator due to phrenic nerve paralysis, early diagnosis and continued long-term rehabilitation may make it possible to wean the patient from the ventilator.

ACKNOWLEDGEMENTS

We would like to thank Editage (<http://www.editage.com>) for editing and reviewing this manuscript for English language.

Received: April 19, 2023. Revised: November 20, 2023. Accepted: November 27, 2023

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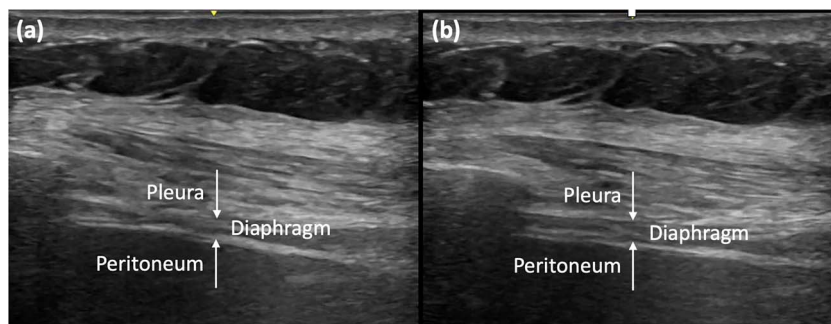


Figure 2. Ultrasonographic images of diaphragms. (a) Diaphragm at the end-expiratory stages. (b) Diaphragm at the end-inspiratory stages, showing that it did not thicken.

CONFLICT OF INTEREST STATEMENT

YM received lecture fees from MSD K.K., the Japan Blood Products Organization, and an industry-academia collaborative research grant from JIMRO Co., Ltd. The other authors have no conflicts of interest to declare.

FUNDING

This work received no external funding.

ETHICAL APPROVAL

Ethical approval was not required.

CONSENT

Written consent was obtained from the patient for this publication.

GUARANTOR

Masayuki Akatsuka is the guarantor for this publication.

REFERENCES

1. Fraser CD 3rd, Ravekes W, Thibault D, Scully B, Chiswell K, Giuliano K. *et al.* Diaphragm paralysis after pediatric cardiac surgery: an STS congenital heart surgery database study. *Ann Thorac Surg* 2021;**112**:139–46.
2. Joho-Arreola AL, Bauersfeld U, Stauffer UG, Baenziger O, Bernet V. Incidence and treatment of diaphragmatic paralysis after cardiac surgery in children. *Eur J Cardiothorac Surg* 2005;**27**:53–7.
3. Akay TH, Ozkan S, Gultekin B, Uguz E, Varan B, Sezgin A. *et al.* Diaphragmatic paralysis after cardiac surgery in children: incidence, prognosis and surgical management. *Pediatr Surg Int* 2006;**22**:341–6.
4. Gerard-Castaing N, Perrin T, Ohlmann C, Mainguy C, Coutier L, Buchs C. *et al.* Diaphragmatic paralysis in young children: a literature review. *Pediatr Pulmonol* 2019;**54**:1367–73.
5. Fayssoil A, Mansencal N, Nguyen LS, Orlikowski D, Prigent H, Bergounioux J. *et al.* Diaphragm ultrasound in cardiac surgery: state of the art. *Medicines (Basel)* 2022;**9**:5.
6. Tralhão A, Cavaleiro P, Arrigo M, Lopes JP, Lebrun M, Rivas-Lasarte M. *et al.* Early changes in diaphragmatic function evaluated using ultrasound in cardiac surgery patients: a cohort study. *J Clin Monit Comput* 2020;**34**:559–66.