Proposal for bail-out procedures - Assisted circulation

Successful interventional closure of a patent foramen ovale in a pediatric patient supported with a biventricular assist device

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Abstract

We report on a 16-year-old boy after an event of cardiac arrest and initial treatment with a veno-arterial extracorporeal membrane oxygenator (ECMO). After a short stabilisation period a biventricular assist device (BVAD, Thoratec) was implanted. Although the BVAD was functioning well, the patient showed persisting hypoxemia. Transthoracic echocardiography revealed a patent foramen ovale with a high right-to-left shunt due to low aspiration pressures of the BVAD. The patient was successfully treated by interventional closure of the PFO with a 27-mm Amplatzer septal occluder and could easily be weaned from the respirator. Meanwhile the boy has successfully undergone heart transplantation. PFO has to be considered as a cause of arterial hypoxemia in patients supported with assist devices. The diagnosis of a PFO may be missed under ECMO-treatment. Intervventional closure of a PFO can successfully be performed even if the patient is supported with a BVAD.

Keywords: Ventricular assist device; ECMO; Patent foramen ovale; Interventional closure; Amplatzer septal occluder; Arterial hypoxemia

1. Background

Implantation of cardiac assist device is a well recognized procedure to bridge acute heart failure until myocardial recovery or heart transplantation [1]. There are only a few reports on patients supported by ventricular assist devices who suffer recurrent hypoxemic crises due to a patent foramen ovale (PFO) [2–6]. Even so, PFO is not regularly considered as a differential diagnosis of right-to-left shunt in patients supported with assist devices. In our patient the PFO was not diagnosed due to extracorporeal membrane oxygenator (ECMO) treatment prior to the implantation of the biventricular assist device (BVAD).

2. Case report

We report a 16-year-old boy who suffered from dilatative cardiomyopathy due to a Coxsackie-Type-B-Virus infection. After an event of cardiac arrest and cardiopulmonary resuscitation, the patient was treated with an ECMO implantation with jugular canulas due to persisting low output failure in another hospital. After admission to our hospital, the ECMO was urgently explanted and a biventricular assist device (Thoratec®) was implanted. Despite initial cardiovascular stabilisation during the next days, persisting episodes of arterial hypoxemia were observed. Transthoracic echocardiography revealed a PFO with right-to-left shunt. Negative pressures of the left atrial aspirator (~20 mmHg) of the Thoratec® device helped to maintain a high shunt volume. The patient was transferred to the catheter laboratory where a right heart catheterisation was performed. A 27-mm Amplatzer septal occluder was introduced and released into the PFO immediately (Fig. 1). After closure, there was only a minor right-to-left shunt and oxygen saturation levels rose to normal values (see Table 1). Oxygen supplementation was reduced efficiently during the next hours and the boy was extubated. In the follow-up period of 80 days, there were no further complications due to the assist device. After that period, the patient was successfully transplanted using the bicaval technique. The patient was discharged home in the meantime three months post-transplant.

3. Discussion

Only a few reports describe a persisting foramen ovale as an underlying cause of right-to-left shunt in patients being supported with left or biventricular assist devices [2–6]. Nevertheless, PFO may be the reason for refractory arterial hypoxemia in patients with a ventricular assist device who fail to respond to escalation of ventilatory support. With the BVAD in place, the negative pressures, which are necessary to aspirate the blood may re-open a PFO, which is only functionally closed under normal physiological conditions. Deoxygenated blood from the right atrium is aspirated through the PFO into the assist device and ejected into the systemic circulation mimicking severe ventilatory problems.
Fig. 1. Anteroposterior (AP) fluoroscopy during catheterisation. (a) Balloon-sizing showing a patent foramen ovale. (b) Occluder in position after successful closure of the patent foramen ovale. The canulas in the right ventricle and the left atrium are not visible. T: transoesophageal probe; A: right atrial aspiration canula; L: left ventricular canula; B: insufflated balloon sizing PFO; Asterisk: Occluder device in position of PFO.

with low arterial oxygenation. As demonstrated in our patient, the closure of PFO by interventional catheterisation can be safely performed with BVAD in place. Due to the ECMO-support it was not possible to exclude a PFO initially when the patient arrived in our department.

Table 1
Haemodynamics before and after closure of PFO on BVAD

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO₂ (mmHg)</td>
<td>267</td>
<td>88</td>
</tr>
<tr>
<td>O₂ supplementation (%)</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Mean arterial pressure (mmHg)</td>
<td>98</td>
<td>106</td>
</tr>
<tr>
<td>Central venous pressure (mmHg)</td>
<td>11</td>
<td>15</td>
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</tbody>
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4. Conclusion

PFO with right-to-left shunt is a rare cause of persisting arterial hypoxemia in paediatric patients who are supported by a biventricular assist device. The diagnosis may be missed under ECMO-treatment. Interventional closure of the PFO could be performed safely in our BVAD-treated paediatric patient.

References