CASE REPORT

Atrial septal defect and training-induced changes in loading conditions: clinical management and implications for competitive athletes

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SUMMARY

Atrial septal defect (ASD) is the most common congenital heart disease in adults. When right heart dilation occurs, prompt closure should be considered. In the athletic population, however, the management of ASD can be challenging. Indeed, while the training-induced haemodynamic effects on the right heart of an athlete with open ASD are not well known, possible device-related consequences may occur after percutaneous closure. We report the case of a competitive athlete with secundum ASD in which changes in the training regime significantly affected the right heart. Prompt normalisation of right ventricular size and of pulmonary artery pressures was demonstrated 2 months after percutaneous ASD closure.

BACKGROUND

Atrial septal defect (ASD) is the most common congenital heart disease in adults.^{1 2} Current evidence suggests that all types of ASDs with right heart dilation should be considered for timely closure once the diagnosis is established, irrespective of age.³ However, in the athletic population, the clinical evaluation is complicated by the presence of exercise-induced right ventricular (RV) dilation, and the management of ASD may be challenging due not only to changes in loading conditions, but also to possible device-related consequences after percutaneous correction. Furthermore, for subjects with an open ASD, the consequences on the RV and the timeline for RV recovery after ASD correction are not well established in the athlete. We report a case of an open ASD in an athlete who changed his workout plan, undergoing a late percutaneous closure of the defect. The case demonstrates the complex relationship between ASD and exercise, and the haemodynamic consequences for the RV.

CASE PRESENTATION

A 24-year-old Caucasian man, playing soccer, was referred to our laboratory for evaluation of secundum ASD with left-to-right shunt. He had neither symptoms nor cardiac risk factors. One year earlier, the patient was evaluated in another centre. Despite the presence of a large ASD, right atrium and RV were both mildly enlarged (mid-cavity end-diastolic diameter (EDD) was 37 mm; [figure 1A](#)) and systolic pulmonary artery pressure (SPAP) was normal (30 mm Hg). At that time, the athlete trained 5 h/week. After 1 year, an echocardiogram was repeated in our centre. We found a significant dilation of the RV (mid-cavity EDD was 43 mm) and an increase in SPAP, measuring 40 mm Hg ([figures 1B and 2A](#)), with a significant left-to-right shunt due to the secundum ASD ([video 1](#)). The left ventricular systolic and diastolic parameters were normal. It is noteworthy that during that year, the volume and intensity of training dramatically increased and the player trained 10 h/week. A transoesophageal echocardiogram was performed confirming the presence of a large secundum ASD (14×18 mm) with adequate rims for performing a transcatheter repair. According to the haemodynamic impact of ASD, in January 2014, a percutaneous ASD closure was successfully performed using Amplatzer septal occluder (St Jude Medical, St Paul, Minnesota, USA).

OUTCOME AND FOLLOW-UP

A strict postoperative echocardiographic follow-up was performed to evaluate the RV recovery time. Despite the RV dilation, RV strain was normal both before and after ASD closure, measuring -31%. [Figure 1](#) shows the progressive reduction both in RV dimensions and in SPAP after ASD correction. Two months after the procedure, RV dimensions

Figure 1 Echocardiographic estimation of right ventricular (RV) size. (A) During the low-volume, low-intensity training programme, echocardiographic examination revealed only a mild dilation of the RV. (B) After 1 year of intensive exercise, we found a significant dilation of the RV with an increase in systolic pulmonary artery pressure. (C) Early normalisation of RV cavity size after percutaneous correction of septal defect, observed 2 months after the procedure.

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Figure 2 Estimation of systolic pulmonary artery pressure (SPAP). (A) During the intensive training programme, SPAP increased, measuring 40 mm Hg. (B) After percutaneous correction of atrial septal defect, normalisation of SPAP was observed 2 months after the procedure.

returned within the normal range, with RV mid-cavity EDD measuring 34 mm (figure 1C), SPAP 30 mm Hg and no residual shunts observed (figure 2B).

DISCUSSION

Larger defects with evidence of RV volume overload on echocardiography usually only cause symptoms in the third decade of life, and their closure is usually indicated to prevent long-term complications such as atrial arrhythmias, reduced exercise tolerance, haemodynamically significant tricuspid regurgitation, overt congestive cardiac failure, or pulmonary vascular disease.⁴ In athletes, intensive training leads to morphological changes of the right heart, and RV dilates to cope with the load increase during intensive exercise with its function remaining preserved.⁵ Thus, while the evaluation of the haemodynamic impact of ASD on RV size in athletes may be difficult, training-induced changes in volume and pressure overload may represent a challenge for the RV, particularly in the presence of a large ASD. According to current recommendations, athletes with ASD without pulmonary hypertension, RV dilation, or significant arrhythmias, can carry out all sporting activities, including diving apnoea, excepting those with underwater breathing apparatus,^{6,7} while closure is indicated in presence of large ASDs and evidence of RV volume overload. In this case we observed a relationship between training volume and haemodynamic relevance of an open ASD with left-to-right shunt. We found indeed that while RV size and SPAP were normal during low-volume practice of sports, when the training volume and intensity increased, significant haemodynamic consequences on the RV were observed. These findings seem to suggest that changes in training volume and intensity could worsen the haemodynamic consequences of an open ASD. Further data are needed to evaluate whether

the type of sport and its intensity may impact significantly on the management of an open ASD in athletes.

In the corrected forms, the 6-month evaluation of RV recovery is important for the athlete population because there may be the loss of eligibility to play sports in case of persistent significant RV dilation, RV dysfunction and residual pulmonary hypertension.⁶ Recovery of RV function and participating in competitive sports after ASD closure has been described in athletes.⁸ In this case, we found that recovery of RV dimensions occurred earlier than expected, with complete normalisation of RV cavity size 2 months after the procedure. We also observed that SPAP decreased rapidly. The complete recovery of RV dimensions in this case was due to the RV's ability to sustain volume overload and to the patient's young age, and was favoured by detraining. Our observations therefore seem to suggest that, after ASD closure, clinical re-evaluation to demonstrate RV recovery may be performed even in the early phases after the intervention.

Device closure has become the first choice for secundum defect closure, when feasible. Although serious complications were observed in $\leq 1\%$ of patients^{9,10} and erosion of the atrial wall or the aorta as well as thromboembolic events appear to be very rare,^{11,12} Santini *et al*¹³ described a case of cardiac perforation caused by a dislocation of atrial septal occluder during intense isometric exertion. Caution should therefore be maintained for the indication to ASD closure in athletes engaged in contact sports when physical contact between players is part of the sport itself, as it is in soccer.

Finally, the possibility of device-induced supraventricular arrhythmias has to be taken into account, not only for the health condition, but also because in presence of paroxysmal, persistent and permanent supraventricular tachyarrhythmias, eligibility is not granted, according to current recommendations.⁶

In conclusion, this case highlights the need to correct a large ASD in competitive athletes, due to worsening of

Video 1 Parasternal short-axis view performed during the intensive training programme. A large secundum atrial septal defect with a left-to-right shunt was found.

Learning points

- ▶ The presence of a large secundum atrial septal defect (ASD) in a competitive athlete engaged in an intensive training programme is associated with significant consequences on the right heart.
- ▶ Changes in training regime can markedly affect and worsen the haemodynamic consequences of a large, open ASD in competitive athletes.
- ▶ Although there are concerns about possible device-related consequences after percutaneous closure in competitive athletes, prompt normalisation of right heart size and pressures can be observed 2 months after the procedure.

haemodynamic consequences induced by intensive training programmes. Caution should, however, be maintained for the indication to ASD closure in cases of small defects, and particularly in patients engaged in low-intensity, low-volume training programmes. This is also in view of the rapid reversibility of RV size and pulmonary artery pressures in the corrected forms of young athletes.

Contributors FD and AM performed the echocardiographic analysis and wrote the manuscript. MB and SM critically revised the manuscript. FD, MB and SM developed the original idea for this work.

Competing interests None declared.

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