Total endoscopic robotic atrial septal defect repair in a patient with dextrocardia and situs inversus totalis

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Abstract
Situs inversus with mirror-image of the heart is a rare condition. The present report describes a case of a patient with dextrocardia with situs inversus who had atrial septal defect with multiple holes in the fossa ovalis. The patient underwent total endoscopic atrial septal defect repair using the da Vinci surgical system. This procedure was achieved safely with good clinical and excellent cosmetic results.

Keywords: Minimally invasive cardiac surgery • Robotic surgery • Endoscopic surgery

INTRODUCTION
Atrial septal defect (ASD) is one of the most common congenital heart diseases found in adults. Conventional ASD closure with median sternotomy or thoracotomy has been successfully performed with low morbidity and mortality. Various minimally invasive surgical approaches have been applied to minimize the need for surgical incisions and to improve cosmetic results [1]. For example, transcatheter closure of a secundum ASD using different types of devices has been employed [2]. Further, in 2001, Torracca et al. [3] described a technique of total endoscopic closed-chest ASD closure using a robotic device (da Vinci System; Intuitive Surgical, Inc., Mountain View, CA, USA).

Dextrocardia with situs inversus is the most common variety of dextrocardia. Among a subgroup of patients with situs inversus dextrocardia with concordant AV connections, ASD was relatively rare [4].

The present study describes a case in which total endoscopic robotic closure of secundum ASD with multiple holes was performed in a patient with dextrocardia and situs inversus totalis.

CASE REPORT
A 33-year-old woman was diagnosed as dextrocardia and situs inversus with secundum ASD shortly after birth. Serial echocardiography demonstrated a gradual increase in the pulmonary blood flow (Qp)-to-systemic blood flow (Qs) ratio beginning at the age of 27 years. At the age of 32 years, Qp/Qs was 3.2, and she was referred for ASD closure. An electrocardiogram revealed right-axis deviation and intraventricular delay. Chest X-ray revealed the presence of dextrocardia with situs inversus and a cardiothoracic ratio of 55% (Fig. 1). Two-dimensional echocardiography revealed secundum ASD, a left-to-right shunt and volume overload in the right atrium and ventricle. Transoesophageal echocardiography (TEE) confirmed the diagnosis of ASD with multiple holes (maximal diameter, 20 mm) in the fossa ovalis without enough tissue surrounding the defects to enable transcatheter ASD closure. After discussion with cardiologists, closure of the ASD with multiple holes was elected using the da Vinci surgical system.

Anaesthesia was induced using standard techniques and a double-lumen endotracheal tube for single lung ventilation. The patient was placed in a slightly right lateral decubitus position. After systemic heparinization, an outflow cannula (PCKC-V 16 Fr, TOYOBO, Osaka, Japan) was inserted transcutaneously into the left internal jugular vein and positioned into the superior vena cava. Inflow cannulas (PCKC-A 14 Fr, TOYOBO, Osaka, Japan) were inserted into the bilateral femoral arteries, and an outflow cannula (V FEM 22 Fr, Edwards Lifesciences, Irvine, CA, USA) was inserted into the left femoral vein. At the anterior axillary line, a 0° endoscope was inserted through the fourth intercostal space, the arms of the robot were inserted through second and sixth spaces and the service port was placed in the fourth space. Cardiopulmonary bypass (CPB) was initiated, and the vena cavae were occluded using tape to complete the bypass. Aortic occlusion was performed using a Chitwood cross-clamp via the second intercostal space, and antegrade cold blood cardioplegia was administered directly through the anterior thoracic wall with long cannula. A right atriotomy was performed, and the secundum ASD with multiple holes was confirmed. The ASD was directly closed with 4-0 Gore-Tex in running suture. After cross-clamp release and meticulous intracardiac de-airing, the patient was weaned from CPB, and chest tubes were inserted. The integrity of the ASD closure was confirmed by TEE. The extracorporeal circulation and cardiac arrest times were 58 and 18 min, respectively, and the estimated blood loss volume was 80 ml. Extubation was performed in the operating room right after the operation. The patient was able to walk on the day following the operation. She resumed a completely normal lifestyle...
by 1 week after the operation, and the cosmetic result was excellent (Fig. 2). Postoperative transthoracic echocardiography revealed no residual shunt.

**DISCUSSION**

Although surgical ASD repair with conventional median sternotomy is effective and is associated with low morbidity and mortality, a minimally invasive approach that does not utilize sternotomy is desirable for a variety of reasons. This consideration has led to the development of the minithoracotomy technique with submammary incision. In parallel, recent advances in transcatheter closing devices has resulted in a shift from surgical repair to interventional closure for treatment of secundum and patent foramen ovale types of ASD. However, the presence of a large ASD or multiple ASDs with an insufficient surrounding tissue to anchor the closure device is associated with higher procedural failure rates. Recurrence of the intracardiac shunt, dislodgement of the occluder and breakage of the device have also been described [5, 6]. These complications may require emergency operations to remove the device. Therefore, rigorous patient selection is mandatory.

Alternatively, total endoscopic robotic surgery can be offered for ASD closure regardless of ASD size, location and shape. Some authors have already reported that robotic surgery can be performed with mortality and morbidity rates similar to those associated with open-chest operations [3, 7, 8], and avoidance of thoracotomy or sternotomy has yielded potential benefits in terms of faster recovery and quick return to a normal lifestyle.

Situs inversus with mirror-image of the heart is a rare condition, and this is the first report of total robotic ASD repair in a patient with dextrocardia with situs inversus totalis. Robotic surgery in a patient with dextrocardia with situs inversus totalis was performed using bilateral arterial cannulation of the femoral artery in this patient, as the size of the femoral arteries is not large enough for establishment of CPB with single femoral arterial cannulation. Venous cannulations were performed through the left jugular and the left femoral veins. Aortic occlusion was completed safely with a Chitwood cross-clamp through the second intercostal space in the left midaxillary line. Antegrade cardioplegia was administered directly through the anterior chest, which proved safe and feasible. The da Vinci surgical system was not associated with any limitations during total endoscopic atrial septal repair in a patient with dextrocardia with situs inversus totalis.

In conclusion, total endoscopic atrial septal repair using the da Vinci surgical system in a patient with dextrocardia with situs inversus totalis was achieved safely with good clinical results and excellent cosmetic results.

**Conflict of interest:** none declared.

**REFERENCES**

This interesting case report [1] provides an opportunity to discuss several points. It has been mentioned that the incidence of morbidity and mortality is similar to the open procedure. The incidence of conversion to open sternotomy or need for thoracotomy is inherent in such a procedure and is currently not known.

There appears to be an additional risk of injury to other anatomical structures due to placement of the ports and their manipulation. The placement of drains was presumably in order to drain the pleural space as well.

It would be important to know if it is the authors’ practice to use a robotic technique in preference to an open technique to close straightforward atrial septal defects in terms of risk versus benefit to the patient.

Presumably additional investigations are needed during the pre-operative work-up stage to demonstrate vascular anatomy for robotic placement of cannulae.

Conflict of Interest: None declared

Reference