Successful Robot-Assisted Repair of Congenital Mitral Valve Regurgitation

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Congenital mitral valve regurgitation (CMR) is very uncommon in adults and is usually associated with other congenital malformations. Repair of the mitral valve remains the standard of care. Very limited reports are available on minimally invasive surgical approaches in treating CMR. This report represents the first case series of the successful application of robotics in correcting CMR and associated anomalies, including a partial atrioventricular canal defect.


Robotic techniques have been used successfully in older children and adults with extracardiac lesions such as patent ductus arteriosus and vascular rings [1]. The use of robotics in treating congenital cardiac lesions in children is limited by body surface area, complexity of the lesion, and the need for larger ports to manipulate the instruments [2]. Congenital mitral valve regurgitation (CMR) is uncommon, with an incidence of about 2% in all adults undergoing mitral valve operations, with leaflet prolapse being the predominant cause [3, 4]. Even though robot-assisted mitral valve intervention is used widely in treating acquired mitral valve disease, very little has been reported of this technology being used in the treatment of congenital mitral valve disease. We report the successful use of robotic assistance in treating CMR with and without associated heart defects in 3 consecutive patients.

Case Reports

Patient 1

A 54-year-old man with a known partial atrioventricular canal defect (PAVC) was referred for surgical evaluation. Transesophageal two-dimensional echocardiography confirmed a PAVC with a 20-mm ostium primum defect, dilated right-sided cardiac chambers, and a zone of apposition (ZOA) in the anterior mitral valve with severe mitral valve regurgitation. Cardiac catheterization showed a significant intracardiac shunt, with a Qp/Qs ratio of 1.8:1 and normal coronary arteries. Preoperative computed tomography of the chest, abdomen, and pelvis...
demonstrated normal arterial and venous vasculature. Given the dilated cardiac chambers and significant intracardiac shunt, surgical repair was advised.

Surgical preparation was performed according to the published Mayo Clinic robot-assisted mitral valve protocol [5]. Once the heart was arrested, small vascular clamps were applied to the superior vena cava and the inferior vena cava. Through a right atriotomy, the ostium primum atrial septal defect (ASD) was closed with a bovine pericardial patch (Supple Peri-Guard, Synovis, MN) leaving the coronary sinus on the right atrial side. To avoid interference with the conduction tissue, the inferior edge of the patch was sutured along the annular edge of the anterior mitral leaflets with 4-0 polypropylene suture, the remainder of the patch being anchored to the ASD margin. The right atrium was closed in two layers. The left atrium was opened with an incision posterior to the interatrial groove. The ZOA in the anterior mitral leaflet was identified, and its margins were confirmed by the attachment of primary chordae. The ZOA was closed along its entire length in two layers with 3-0 polypropylene suture in a continuous manner. A posterior annuloplasty was then performed with use of a 63-mm annuloplasty band (Medtronic, Minneapolis, MN). Valve competency was inspected with saline insufflation. The aortic cross-clamp was removed after 104 minutes, and cardiopulmonary bypass was weaned. The integrity of the repair (mild regurgitation) and adequacy of deairing were confirmed with two-dimensional echocardiography (Fig 1). The patient was extubated in the operating room. Brief episodes of atrial arrhythmias prolonged his hospital stay from 3 to 5 days. He returned to his normal activities within 2 weeks after hospital dismissal and is doing well at the 2-year follow-up.

Patients 2 and 3
Two other patients underwent closure of ZOA in the anterior mitral valve with the use of robotic assistance (Table 1). A mitral annuloplasty band was placed for the second patient in view of a dilated annulus; it was not used for the third patient, who had a normal annulus.

Comment
Congenital cleft malformation (ZOA) in an otherwise normal mitral valve usually present with other concomitant cardiac defects, mainly the primum type of ASD [6]. Isolated mitral valve cleft / isolated mitral valve ZOA without other cardiac lesions is very rare (incidence 1:1340). Isolated mitral valve cleft is defined as cleft/ZOA.
of the anterior mitral valve leaflet not associated with ostium primum defect or other features of ASD [7].

Mitral valve regurgitation and left ventricular outflow tract obstruction resulting from abnormal chordal attachments are the two main clinical sequelae in patients with a mitral valve cleft [8]. The mechanism of mitral regurgitation in isolated ZOA results from a combination of factors. It may be due to the ZOA, annular dilatation, and retraction of edges of ZOA, or it may result from abnormal attachment of the subvalvular apparatus. The degree of mitral valve regurgitation may increase as the patient advances in age. It is usually asymptomatic during childhood in the absence of left ventricular outflow tract obstruction or other associated cardiac lesions.

The surgical options include direct suturing of the ZOA if the edges are pliable without much retraction or the use of a patch to close the ZOA if the edges are retracted. Mitral valve annuloplasty is typically performed in adult patients with annular dilatation.

To the best of our knowledge, this is the first case series of the successful use of robotics in treating congenital mitral valve regurgitation and other associated defects including a partial atrioventricular canal defect. A few technical points should be highlighted. First, we find that the biatrial approach for the partial AV canal defect is preferred because closing the mitral valve cleft and placing the ring annuloplasty through the interatrial defect is difficult in view of the angle needed to use the robotic atrial retractor and arm instruments.

A partial ring annuloplasty is best performed by a left atrial approach and should be included as part of the mitral valve ZOA repair in adults with a dilated annulus. Care should be taken to rotate away from the right fibrous trigone because the AV node is situated in the nodal triangle and hence is at risk for trauma. Inasmuch as patients with a mitral valve ZOA are prone to left ventricular outflow tract obstruction, one must take care to ensure the absence of that obstruction after placing the posterior ring annuloplasty before leaving the operating room.

Conclusion

In conclusion, we present the successful application of robot-assisted mitral valve repair in three cases of CMR and associated intracardiac defects, including one in the setting of PAVC. Although this is a unique series, these patients received the benefits of minimally invasive operations including safe successful repair, early extubation, and shortened hospital stay. As technology improves, the benefits of robot-assisted cardiac operations will likely be increasingly applicable to more forms of congenital cardiac operations.

References