California Pacific Medical Center
A Sutter Health Affiliate
Community Based, Not For Profit

"Touch-Free" Surgery for Congenital Heart Defects

ADVANCED MINIMALLY INVASIVE SURGERY PROGRAM

At California Pacific Medical Center we are committed to bringing new and advanced diagnostic tools, medical treatments and surgical options to the physicians we serve and the patients they care for. Through this procedure profile, our physicians illustrate actual medical situations that provide you with a window into their practice of diagnosis, treatment and patient follow-up.

For patient referrals:
(888) 637–2762

www.cpmc.org

Recent technological advances in cardiac surgery have significantly decreased the morbidity and mortality once associated with congenital heart defects. Now, robotic and videoscopic techniques are complementing refined surgical procedures, enabling surgeons to repair most forms of congenital heart disease using a minimally invasive approach. At California Pacific, the term *minimally invasive congenital heart surgery* describes a surgical philosophy in which the heart is repaired through limited surgical incisions and robotics. With small incisions that only allow room for sterilized instrumentation, the surgeon's hands and fingers rarely touch one's tissue. As a result, patients have a reduced incidence of infection, a shorter hospital stay and better cosmetic results.

In diagnosing and treating children with congenital heart disease, our team routinely incorporates:

- Cardioscopy (intra-cardiac imaging)
- Active venous suction
- Robotic video assistance
- Robotic telemanipulation

What heart conditions can minimally invasive surgery repair?

At California Pacific, minimally invasive surgery is performed on infants, children and adults to repair both simple and complex heart defects, including:

CONGENITAL/ADULT DISEASE REPAIRS

- Complex atrial and ventricular septal defects
- Complex valvular lesions
- Obstructive lesions of both the right and left ventricles
- Patent ductus arteriosus
- Vascular rings
- Heart tumors
- Arrhythmia surgery and pacemaker (epicardial) placement

NEONATAL DISEASE REPAIRS

- Tetralogy of Fallot
- Atrioventricular septal defects
- Arterial switch procedure
- Neonatal Ross procedure
- Single ventricle palliation including the modified Norwood procedure

Torso following "touch free" surgery.

Torso with scar from conventional heart incision.

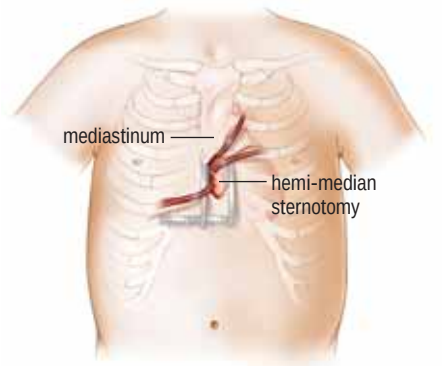
What can patients expect?

With minimally invasive congenital heart surgery, the surgeon performs heart repairs through either a 2-inch chest incision or 3 to 4 small 1-cm incisions on the side of the torso. These small incisions cause little trauma. As a result, patients are extubated early, without the need for prolonged ventilation, and have reduced pain and a shorter hospital stay. Usually, children and adults leave the hospital 2 to 3 days following surgery, versus the 5 to 7 day stay associated with traditional open-heart surgery.

How is the surgery performed?

Congenital heart defects are typically repaired through either a "keyhole" or "port-access" approach:

"KEYHOLE" APPROACH



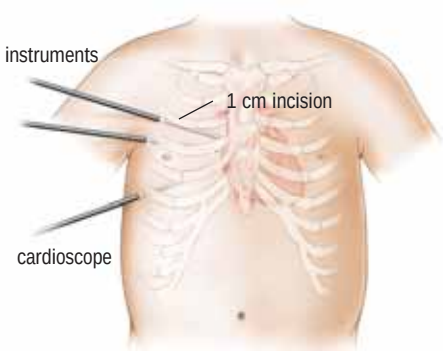
"Keyhole" surgical approach

To access the mediastinum, the surgeon makes a midline incision over the lower two-thirds of the sternum, 4 to 5.5 cm in length. This incision—called a hemi-median sternotomy— avoids risk of injury to potentially developing breast tissue. A limited circumferential skin flap reduces the likelihood of cutaneous tears during the operation and also enhances exposure. Such direct access to the mediastinum allows for:

- correction of defects not previously appreciated;
- the ability to easily extend the incision if required (has not been require to date); and
- superior de-airing of the cardiac chambers.

By using cardioscopic techniques, the surgeon has an enhanced view (magnified and illuminated) of the surgical field, while the patient benefits from a limited skin incision.

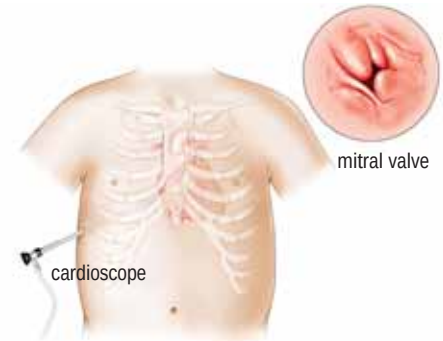
"PORT-ACCESS" APPROACH



Multiple ports allow for total robotic manipulation and/or thoracoscopic manipulation.

The mediastinum is accessed by multiple 1 cm incisions, which allow insertion of either robotically controlled instrumentation (via the da Vinci® system) or handheld thorascopic instruments. Patients typically recover quickly and the small lateral (side) incisions require little postoperative attention.

How do videoscopic and robotic techniques aid repair?



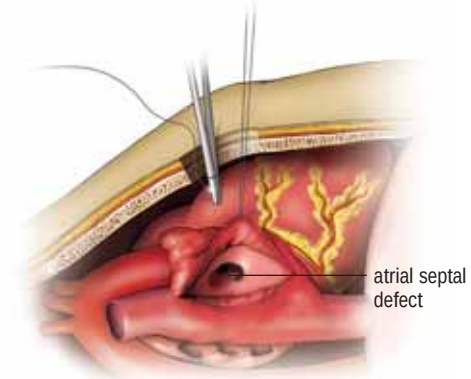
Video-assisted cardiac surgical approach. A mitral valve arcade and supramitral valve ring with severe mitral valve stenosis are shown.

By using a videoscope to view one's heart anatomy, surgeons can repair more complicated congenital heart defects within a confined surgical field. This technique, known as cardioscopy, involves the use of a tiny, fiberoptic camera inserted through a small port to provide the surgeon with a well-illuminated, magnified view of the heart. Scopes ranging in diameter from 2.6 to 5 mm with angled lenses are used to correct obstructive outflow tract lesions and lesions involving shunts, and to assess valvular pathologies. The recent addition of *flexible* cardioscopy has provided a safe and unique way to examine the mitral valve in a retrograde fashion.

In the past decade, surgeons have begun using voice-activated robots with cardioscopy to assist in the repair of both simple and complex congenital heart defects. Robotic units help by:

- Guiding the cardioscope within the chest;
- Providing better visualization in the surgical field;
- Significantly lowering infection rates.

Robotic-stabilized instruments can fit into a smaller incision than the human finger, thereby enabling "touch free" surgery and consequently, barely negligible rates of post-operative infection.



Robotic video-assisted surgical approach

At California Pacific, our cardiac surgeon can repair congenital heart defects with robotic telemanipulation. This procedure uses robotic-stabilized instruments within a patient's chest cavity, which are guided by the surgeon's hand movements. Small, 1 cm incisions provide access for the robotic instruments. Using 3-D visualization techniques and an operative console, the surgeon uses open-surgery hand movements that are precisely replicated in the operative field. Delicate maneuvers, such as sewing and cutting with 5 mm and 8 mm instruments, are regularly performed with robotic telemanipulation.

Robotic Telemanipulation Cardiac Surgery

Robotic Fetal Techniques

Diagnosis of fetal cardiac disease can be ascertained as early as 16 weeks gestation with current ultrasound technologies. When a severe defect is found, some advocate removing the fetus from the uterus to undergo cardiopulmonary bypass and then reimplant it. An alternative to this philosophy is fetoscopy, or micromanipulation with long instrumentation under robotic control.

Fetoscopy is now enhanced by robotic telemanipulation, which removes tremor amplification. With robotic telemanipulation, the surgeon has direct visualization and controlled robotic manipulation of the chordal vessels. This allows direct access of the cardiac chambers via catheters and the opportunity for intra-cardiac manipulation. Our surgeon has successfully performed this technique in a laboratory setting and hopes to bring it to the clinical setting soon.

How do minimally invasive congenital heart surgery outcomes compare?

Outcomes for minimally invasive congenital heart surgery have shown to be equally successful as open-heart surgery during the past nine years of experience. Additionally, published research has shown that the benefits of minimally invasive surgery, such as reduced tissue trauma and pain, earlier discharge, reduced infection rate, and decreased length of stay, are advantageous for patients.

How long does the procedure typically take?

Minimally invasive congenital heart surgery for both children and adults typically involves a four- to six-hour procedure in the operating room (similar to conventional procedures). Patients are given general anesthesia and commonly awakened in the operating room upon completion of surgery and removal of the breathing tube. Initially, patients recover in the Intensive Care Unit (ICU), with transfer to the general ward in about 24 hours. Patients typically receive intravenous narcotics as an initial analgesic and are then weaned to oral agents (e.g., narcotics and/or ibuprofen) as tolerated.

"I left the hospital three days after surgery and was out shopping the next morning. I no longer felt short of breath going up the hill to my home. I can't believe I lived like that for so many years. Thank you for renewing my life. My family now has a healthier, happier and more energetic Anna."

— Anna Friedler
Robotic Surgery Patient

What is the average length of stay?

The post-operative length of stay using robotic applications in pediatric cardiac surgery is two days for the majority of patients. Adults frequently require an additional day.

What is the infection rate?

Infection rates with "touch-free" and minimally invasive surgery are significantly lower (below 1%) than with open surgery, due largely in part to the smaller incision and minimized tissue trauma.

case studies

Case 1: Repair of VSD and Pulmonary Valve Stenosis to Correct "Pink" Tetralogy of Fallot

Overview

At birth, an infant male was diagnosed with a large anterior malaligned perimembranous ventricular septal defect (VSD) and pulmonary valve stenosis (a form of Tetralogy of Fallot). During initial visits with his cardiologist, he was growing well and progressing normally. However, after the infant was diagnosed with an upper respiratory tract virus at two months, the cardiologist advocated minimally invasive surgery to close the ventriculoseptal defect and relieve the pulmonary valve obstruction. This would result in avoidance of future respiratory tract infections and relief of the significant peak gradient (80 mmHg) across the right ventricular outflow tract.

Treatment

Because of the infant's VSD, balloon valvuloplasty of the pulmonary valve was not recommended and surgical repair was necessary. In the operating room, a limited skin incision, hemi-median sternotomy incision and pericardotomy were performed. Using the minimally invasive keyhole approach, the ductus arteriosus was dissected and ligated, and a right superior pulmonary vein vent was placed on suction into the left ventricle.

Via the tricuspid valve, the surgeon identified a large anterior malaligned ventriculoseptal defect. Using an autologous pericardial patch, the surgical team was able to obliterate this source of shunting (at the ventriculoseptal level). Next, a pulmonary arteriotomy was fashioned and the pulmonary valve inspected. An extensive commissuroplasty was performed and the valve was released from the pulmonary arterial wall. Intraoperative echocardiography revealed an excellent repair with no significant residual ventriculoseptal defect shunts, and a peak gradient across the right ventricular outflow tract of 24 (versus 74 preoperatively). Given this improvement, closure was performed.

Outcome

The patient was extubated intraoperatively and transported to the PICU in stable condition. His chest and Foley catheter were removed early the next morning. Two days after surgery, he was discharged home. Subsequent follow-up has shown an increased level of activity and no respiratory tract infections or cough. A six-week post surgery echocardiogram showed a mild gradient across the right ventricular outflow tract with very minimal pulmonary regurgitation.

A large anterior malaligned ventricular septal defect. Note the chords to the anterior leaflet of the tricuspid valve were cut in order to unify the defect.

Case 2: Late recognition of large secundum atrial septal defect

Overview

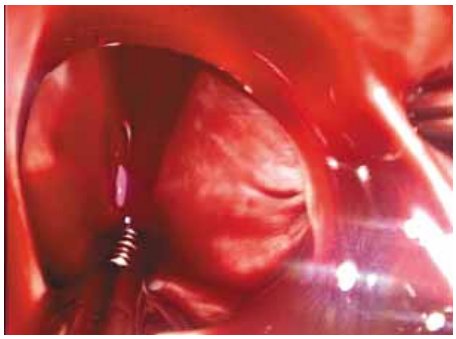
A 29-year old mother of two presented with a medical history of systemic lupus eythematosus and hypertension. She had complaints of chest pain, palpitations and shortness of breath with activity. Echocardiogram studies revealed an atrial septal defect (ASD) measuring 17 mm with left-to-right shunt. There was no evidence of RV hypertension.

Treatment

Using one of our robotic devices, the Zeus™ Telemanipulator, a limited skin incision was made followed by a hemi median sternotomy incision. Two alpha visual ports were used to manipulate and harvest the pericardium after which the 3 CCD thoracoscopic camera and instruments were used for the remaining surgery. With the heart fibrillating, the surgeon tightened both caval snares and fashioned a vertical right atriotomy. A 4-0 polypropylene suture was used to obliterate the source of shunting using the previously harvested pericardial patch.

Outcome

The patient was extubated intraoperatively and transported to the ICU in stable condition. One day following surgery, she was transferred to the surgical floor, tolerating solid foods. She discharged home 48-hours after surgery, resuming the normal activities of daily living.



Very large atrial septal defect of the Secundum type. There is total deficiency of the Septum Primum. An autologous patch closure was required for surgical closure.

For more information

For more information or patient referrals please contact

Michael D. Black, M.D.
Chief, Division of Pediatric Heart Surgery
Surgical Director, Pediatric and Adult Congenital Heart Program

California Pacific Medical Center
2100 Webster Street, #511
San Francisco, CA 94115
Tel. (415) 600-1KID (1543)
Fax. (415) 600-1245

Patient Referrals: (888) 637-2762