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Textbook of PHYSIOTHERAPY *for* Clinical Cardiothoracic Conditions



GB Madhuri

SECOND EDITION

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Cardiac Surgery: Closed Heart Conditions and their Physical Therapy Management

CHAPTER 3

The cardiac conditions requiring closed heart surgery are:

1. **Acquired heart disease:** This has two categories:
   a. Mitral stenosis
   b. Aortic stenosis
2. **Congenital heart disease:** This has two categories:
   a. Patent ductus arteriosus
   b. Coarctation of aorta

ACQUIRED CONDITIONS

Mitral Stenosis

Definition

Mitral stenosis is the narrowing of the mitral valve opening which results in reduced blood flow through the mitral valve from the left atrium to the left ventricle.

Mitral stenosis is the narrowing of the mitral valve where blood from left atrium to left ventricle flow is decreased. Mitral stenosis is of two types—congenital and acquired. Congenital mitral stenosis is seen in infants. The acquired type of mitral stenosis is seen in adults. The severity of mitral stenosis is of two types—mild and severe. In mild type of mitral stenosis, there may not be any symptoms in Infants whereas in severe type of mitral stenosis the symptoms can be like shortness of breath, fainting and disability occurs in 7–9 years if the condition is not treated.

Causes

1. Rheumatic heart disease
2. Lutembacher's syndrome: The patient will have symptoms of acquired mitral stenosis and atrial septal defect
3. Atherosclerosis
4. Endomyocardial fibrosis
5. Hunter syndrome: The patient will have symptoms of both cardiomyopathy and mental retardation.

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Pathology

The obstruction to the left ventricular inflow results in rise in pressure in the left atrium and pulmonary circulation. The pulmonary blood flow needs a pressure gradient of 10 mm Hg between pulmonary arteries and veins. To maintain the pressure gradient, the pressure will be above 20 mm Hg and vasoconstriction occurs. This affects the muscular arteries of the lower lobe, which shows medial hypertrophy. The normal mitral valve is 5 cm^2. The stenosis mitral valve is 1 cm^2. The pressure in the left atrium is about 6–12 mm Hg. In stenosis in order to maintain the adequate cardiac output the pressure in the left atrium is increased to 30 mm Hg or higher, so left atrial dilatation occur. The side effects of this causes pulmonary edema, pulmonary hypertension, right ventricular hypertrophy and right ventricular failure and tricuspid regurgitation.

Types of Mitral Stenosis

1. **Leaflet type:** The valves are stiff, rigid, and calcified.
2. **Commissural type:** The valves looks like fusion of commissures.
3. **Chordae type:** The valves looks like chordae and are thick.

Clinical Features of Mitral Stenosis

1. **Pulmonary hypertension:** Dyspnea, cough with frothy sputum, hemoptysis
2. **Right heart failure:** Weakness, fatigue, edema of feet
3. **Atrial fibrillation:** Embolism, blindness, hemiparesis
4. **Valvular lesions:** Mitral regurgitation, aortic regurgitation, and aortic stenosis

Complications of Mitral Stenosis

1. Pulmonary edema
2. Right ventricular hypertrophy and failure
3. Tricuspid incompetence
4. Atrial fibrillation
5. Infections such as subacute bacterial endocarditis, broncho-pulmonary infections
6. Embolism: Cerebral (hemiplegia, aphasia), pulmonary, and renal hypertension
7. Enlarged left atrium

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Diagnostic Tests

X-ray chest

1. Enlarged left atrium
2. Enlarged right ventricle
3. Enlarged pulmonary conus
4. Lungs changes such as pulmonary congestion, pulmonary edema, pulmonary infarction, pulmonary venous hypertrophy
5. Calcification of the mitral valve

ECG

1. **Early stage:** Normal
2. **Later stage:** P wave will be absent

Echocardiogram

This is a diagnostic test, which outlines the heart movements, pumping movements of heart, provides the pictures of heart chambers and valves, provides information about poor functioning of heart valves, weak heart muscles and blood clots in the heart.

Diagnosis of Mitral Stenosis

1. Loud first heart sound is heard
2. Heart murmurs are heard in mitral area
3. Right ventricle is enlarged causing backward displacement of left ventricle
4. Diastolic heart murmur.

Treatment

The treatment for the mitral stenosis will be either medical or surgical.

Medical treatment for mitral stenosis

In mild cases or in the cases where surgery is contraindicated, following are the treatment modalities that needs to be followed:

1. Bed rest
2. Salt-free diet
3. Diuretics such as furosemide increases urine production so decreases blood pressure in the lungs by decreasing the blood volume
4. Beta-blockers or calcium blockers: Slow abnormal heart rate that causes atrial fibrillation
5. Anticoagulants for preventing embolism, blood clot formation, and atrial fibrillation

   Treatment of complications: If drug therapy fails, then surgical treatment is suggested.

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Surgical treatment for mitral stenosis

Heart surgery is done to separate the fused cups. The valves that are badly damaged needs artificial valve surgical replacement. The types of surgeries done are as follows:

1. **Valvotomy**
   a. *A closed valvotomy:* In this procedure, an instrument is inserted through ventricle, which is passed through the mitral valve and then it is dilated within it.
   b. *An open valvotomy:* In this procedure, the heart is opened and the cusps of the valve mobilized under direct vision.
2. **Balloon valvuloplasty**: Transcutaneous balloon dilatation of stenosed valves is now being done with good success rate. In this type of surgery, the valve is stretched open, a balloon on the catheter tip is passed through the vein and heart. Once the balloon reaches the valve, the balloon is inflated and balloon separates the valve cusps.
   Cardiac surgery is contraindicated in older patients with severe valvular deformity.

Advantages

1. Avoids major surgery
2. The valves will be free of stenosis.

Aortic Stenosis

Definition

It is a condition where narrowing of the aortic valve occurs causing decreased blood flow from left ventricle to aorta. Stenosis also affect the pressure in left atrium. It is serious and most common problem. It restricts blood flow from left ventricle to aorta.

Causes

1. **Valvular stenosis:** Rheumatic fever, atherosclerosis, and congenital malformation
2. **Subvalvular stenosis:** Congenital
3. **Supravalvular stenosis**

Pathology

Patient feels weak and can faint due to left ventricle has to work harder to pump blood to aorta secondary to narrowing of the valve and muscular thickening of left ventricular wall. So less blood flow causes heart failure, left ventricular hypertrophy. Myocardial ischemia also occurs lead to arrhythmias and sudden death. When the patient with

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left ventricular hypertrophy exercises the patient will have symptoms like dyspnea, angina and syncope secondary to decreased blood flow in systemic circulation.

Symptoms

1. Angina/chest pain
2. Syncope/fainting
3. Exertional dyspnea
4. Fatigue
5. Pulmonary edema
6. Sudden death
7. Palpitation
8. Decrease in activity level
9. Murmurs

Symptoms in congenital conditions

1. Breathing problem
2. Fatigue of exertion
3. Poor feeding
4. Unable to gain weight

Signs

1. **Pallor:** Pale, grayish white
2. **Cerebral anemia:** Headache, faintness, giddiness, insomnia, irritability, and depression
3. Chest pain

Diagnosis

1. **Pulse:** Raises slowly and falls slowly
2. **Blood pressure:** Low systolic pressure
3. Systolic murmur
4. Second heart sound is soft and absent

Risk Factors

If the aortic stenosis is diagnosed after the age of 60 years the patient may not see any symptoms until 70 or 80 years and the calcium builds up in flaps. But if aortic stenosis is seen as congenital condition then calcium builds up, valves become narrow and stiff.

Investigations

X-ray chest

1. Normal in mild cases

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2. Dilated ascending aorta
3. Aortic valve calcified
4. Left ventricular enlargement

ECG

1. ST-T changes occur
2. Arrhythmia occurs
3. Heart block or left bundle branch block is seen.

Echocardiogram

1. Thickened, calcified, and immobile aortic valve cusps
2. Left ventricular hypertrophy

Complications

1. Pulmonary edema
2. Right ventricular hypertrophy and failure
3. Tricuspid incompetence
4. Atrial fibrillation
5. Infections such as subacute bacterial endocarditis, broncho-pulmonary infections
6. Embolism: Cerebral (hemiplegia, aphasia), pulmonary, and renal hypertension
7. Enlarged left atrium

Treatment

1. **Medical:** In mild aortic stenosis
   a. *Beta-blockers- for angina*
   b. Avoid strenuous exertion and competitive sports
   c. Rest
2. **Surgical:** In severe aortic stenosis
   a. Balloon dilatation of aortic valve gives temporary relief from obstruction
   b. Aortic valve replacement with a prosthetic or tissue valve

CONGENITAL CONDITIONS

Patent Ductus Arteriosus

Definition

The ductus arteriosus is an opening between two major blood vessels from heart called ductus arteriosus. If the ductus arteriosus remains open after birth then it is called patent ductus arteriosus. The ductus arteriosus is a vessel which connects the aorta with the pulmonary

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artery during fetal life. Normally, it closes within few hours after birth. When it remains open, blood from the aorta flows through to the pulmonary artery resulting in two main effects:

1. Reduction of blood flow to the systemic circulation
2. Overfilling of the pulmonary circulation

Small PDA shows no symptoms and there is no need for any treatment.

Large PDA has poor oxygen blood flow to wrong direction, weak heart muscles, and heart failure.

Symptoms

The child will be prone to

1. Respiratory infections
2. Bacterial endocarditis
3. Dyspnea
4. Angina.

Signs

1. The child looks small or undersized
2. Heart failure if the duct is very large
3. Heavy apex beat
4. Mild diastolic mitral flow, murmur may be heard.

Clinical Features

If the shunt is small, then there is no any symptoms seen; but when the ductus is large, growth development may be retarded. No disability in infancy but cardiac failure with dyspnea may be the first symptom. The blood flow from aorta to pulmonary artery is 10–12 L/min.

The small PDA has no signs and symptoms until adulthood but large PDA causes heart failure after birth and symptoms such as easy tiring, breathlessness, rapid heart rate, poor eating and poor growth, sweating while eating, and not gaining weight.

Risk Factors

The higher risk groups are girls, babies born prematurely, babies born at high altitude like 10,000 ft. Before birth the ductus arteriosus connects left pulmonary artery to aorta. It closes at the time of birth. But if present even after birth called as patent ductus arteriosus. The PDA is commonly seen in Turner syndrome and genetic condition like incomplete X chromosome or 1 missing chromosome, so there are 45 chromosomes altogether.

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Investigations

ECG

1. Normal in infancy
2. Left ventricular and left atrial hypertrophy
3. Pulmonary hypertension associated with right ventricular hypertrophy
4. Prolonged PR interval

X-ray

1. Left atrial and left ventricular hypertrophy
2. Calcified ductus

Echocardiogram

Demonstrates the patent ductus arteriosus.

Color Doppler

Suggests the direction of the blood flow.

Complications

1. Pulmonary hypertension
2. Infective endocarditis
3. Congestive cardiac failure

Contraindications for the Surgery

1. Transposition of great vessels
2. Tricuspid or pulmonary atresia
3. Infective endocarditis
4. Congestive cardiac failure

Treatment

Surgical treatment

The PDA should be closed either using medication if doesn't work then surgery is the option because PDA not closed for longer duration causes reverse effect of increased blood volume and to prevent complications. If smaller PDA no treatment is required and it closes by itself.

Coarctation of Aorta

Definition

Constriction/narrowing of the aorta is called the coarctation of the aorta. The function of the aorta is to deliver oxygenated blood via

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systemic circulation to whole body. When the aorta narrows the force on heart increases to deliver the blood to systemic circulation.

Types of Coarctation

1. Preductal or infantile
2. Postductal or adult or juxtaductal
3. Pseudocoarctation

Causes

The common site of the constriction is distal to the origin of the left subclavian artery and the constriction is in the upper region of the ductus. Coarctation of aorta increases load on the left ventricle, which causes increased blood pressure leading to left ventricle hypertrophy. The patient will have bicuspid aortic valve.

Sex

More common in males.

Symptoms

1. Usually no symptoms are seen.
2. Hypertension causes headache.
3. Intermittent claudication and coldness of feet occur.
4. Shoulder pain due to the dilated collaterals.

Signs

1. The upper part of the body may be well developed and the lower limbs are underdeveloped.
2. Left ventricular hypertrophy is seen.
3. Continuous murmur is heard.

Clinical Features

Babies after birth, difficulty in breathing, irritability, difficulty in feeding, and pale skin. If treatment is not given heart failure occurs leading to death.

In older adults and children, chest pain, high blood pressure, nose bleed, headache, leg cramps, cold feet, and muscle weakness.

Investigations

X-ray

Dock's sign: The rib's inferior margin is notched . It is seen in 3–8 ribs secondary to pulsation of dilated collateral arteries and collateral

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blood flow occurs from subclavian artery to internal mammary artery to intercostal arteries.

ECG

1. **Infants:** The ECG will be normal.
2. **Adults:** The left ventricular hypertrophy and left atrial enlargement occurs.

Echocardiography and color Doppler

Echocardiography: This is a diagnostic test, which gives information regarding intracardiac anatomy and intracardiac anomalies.
Color Doppler: This is diagnostic test gives information about new observation and color flow diameter of evaluation.

Digital subtraction angiograph

This is a diagnostic test, which helps to clearly visualize blood vessels in bony and soft tissue structures.

Diagnosis

1. Left arm is underdeveloped
2. Left radial pulse is weak
3. Right side rib notching occurs.

Associated

1. Patent ductus arteriosus
2. Ventricular septal defect
3. Bicuspid aortic valve defect
4. Congenital aortic stenosis.

Complications

1. Infective endocarditis
2. Congestive cardiac failure
3. Hypertension and its complications
4. Subarachnoid hemorrhage
5. Aortic rupture
6. Premature coronary artery disease.

Treatment

Medical

1. Sedation
2. Antihypertensives
3. Prophylaxis for infective endocarditis
4. Treatment for left ventricular hypertrophy.

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Surgical

Between 5 and 20 years of age:

1. Balloon angioplasty (dilatation of the coarctation)
2. Dacron or Teflon graft and end-to-end anastomosis
3. Aortic valve repair
4. Restrict energetic activities for 6 months postoperatively
5. Postsurgical hypertension is common
6. Follow-up for premature coronary artery disease.

PHYSICAL THERAPY MANAGEMENT FOR CLOSED HEART CONDITIONS

The resident is referred to physical therapy management. The physical therapy treatment is divided in to two types:

1. ***Physical therapy evaluation:***
   - First physical therapy evaluation is done
   - Submaximal test is performed to know the functional capacity of the patient. There are maximal and submaximal stress tests. The patients with cardiovascular conditions are tested using submaximal stress test secondary to decreased functional capacity and decreased tolerance to maximal test and also for the safety of the patient.
   - Based on the test aims and goals are planned and rehabilitation program is made. The physical therapy program is of two types—conservative physical therapy when the patient is on going medical treatment. If this fails and if patient requires surgical treatment. The physical therapy program is divided into two phases. Preoperative physical therapy program and postoperative physical therapy program.
   - The rehabilitation is called cardiopulmonary rehabilitation program where the focus on improving the functional capacity of cardiovascular system and pulmonary system so to return the resident to prior level of function.
2. ***Conservative physical therapy:*** The patient is on going medical treatment and along with that patient will participate in rehabilitation program.

S. No.	Aims of physical therapy	Plans of physical therapy
1.	To maintain range of motion	Active exercises
2.	To maintain the strength of muscles	Resistance exercises using Therabands and weights

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S. No.	Aims of physical therapy	Plans of physical therapy
3.	To train the patient for vital sign monitoring	Heart rate, oxygen saturation, blood pressure monitoring and carrying pulse oximeter all times to know heart rate and oxygen saturation
4.	To train postural awareness	Postural education, ergonomic training
5.	To prevent venous pooling after aerobic exercise	Stretching is performed to muscles like hamstrings, quadriceps, upper limb muscles like biceps, triceps and scapular muscles
6.	To encourage warm up and cool down	Warm up is important for cardiac patient so maintain stable vital signs and prevent cardiac arrest
7.	To include balance training	Static and dynamic balance activities
8.	To include gait training	To focus on proper gait training, avoid abnormal gait and use of assistive devices if necessary
9.	To include stair climbing training	Ascending and descending stair climbing using siderails
10.	To train for energy conservation	Activity pacing and energy conservation, prevent fatigue

Surgical Physical Therapy Management

The physical therapy program for a patient who will be undergoing surgery is divided into two types and four phases:

Types

1. *Preoperative surgical physical therapy:* The preoperative training helps the patient mentally and physically ready for the surgery and also helps to prevent any complications.
2. *Postoperative physical therapy:* This training helps the patient to return to prior level of function.

Phases of Physical Therapy Program

1. Phase I or inpatient cardiac rehabilitation: In hospital, monitor vital signs, effects of bed rest, decrease risk factors.
2. Phase II—convalescent stage or recovery stage: Vital signs monitor, moderate exercise regime 6–8 weeks.
3. Phase III—maintenance stage: Risk factors modification, community exercise program.

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4. Phase IV or commitment phase or ongoing for the life phase: This phase includes diet, behavior modification, monitoring vital signs, home exercise program.

The following are the aims and goals:

S. No.	Aims of physical therapy	Plans of physical therapy
1.	To monitor the vital signs	The important vital signs to be monitored are heart rate, oxygen saturation and blood pressure
2.	To decrease the effects of bed rest	Frequent changing of positions in bed-like performing bed mobility, sitting with head end of the bed raised, sitting at the edge of the bed, chair at least few times as tolerated after surgery
3.	To decrease the risk factors	Ambulate short distances as tolerated
4.	To perform exercise program	Include warm up, aerobic exercises, cool down as tolerated
5.	Home exercise program	Walking, aerobic exercises, strengthening exercises to maintain good health and prevent complication, return to prior level of functions

Pulmonary rehabilitation program: This is a physical therapy intervention to train the pulmonary system effectively and efficiently to perform its functions. Patient is trained with the special techniques that helps to maintain and get back to shape.

S. No.	Aims of physical therapy	Plans of physical therapy
1.	To mobilization and removal of secretion	Active and passive techniques are used. Active technique where the patient performs by himself and passive techniques where physical therapist helps patient to perform the technique to remove secretions. Passive techniques are postural drainage, percussion, vibration and forced expiratory techniques like coughing and huffing *Active techniques:* ACBT (active cycle breathing techniques), thoracic expansion exercises, forced expiratory techniques like coughing and huffing
2.	To improve breathing efficiency	Breathing exercises like diaphragmatic breathing, segmental breathing, lateral costal breathing, glossopharyngeal breathing, and pulse lip breathing
3.	To teach postural awareness	Postural education and ergonomic training

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Contd...

S. No.	Aims of physical therapy	Plans of physical therapy
4.	To strengthen the muscles	Strengthening exercises using Theraband and weights
5.	To teach energy conservation and reduce fatigue	Activity pacing and energy conservation techniques
6.	To reduce stress	Yoga and medication
7.	To teach home exercise program	Warm up, aerobic exercises and cool down (stretching upper limb and lower limb muscles to prevent venous pooling)

The cardiac and pulmonary rehabilitation are the specially designed program for patients suffering from both cardiac and pulmonary conditions. The rehabilitation program helps the patient to return to their prior level of function.

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Textbook of Physiotherapy for Clinical Cardiothoracic Conditions

Salient Features

- The book has been prepared as per the curriculum of subject Cardio-thoracic Clinical Conditions and its Physiotherapy Management for both Bachelors and Master degree Physiotherapy courses at various universities
- The subject Cardiothoracic Clinical Conditions and Physiotherapy Management has been devised as per MCI regulations
- The book has up-to-date information from the introduction to the recent advances
- The book will be useful for Physiotherapists, Teachers, Doctors, Rehabilitation Professionals and other paramedics.

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