HISTORY

16-year-old white male.

CHIEF COMPLAINT: Chest pain of three weeks duration.

PRESENT ILLNESS: His right chest and shoulder pain began several days after he started intensive practicing for the tennis team. The pain is increased by right arm movement and the area is also sore and tender to the touch.

FAMILY HISTORY: His 50-year-old father recently had a heart attack, causing his parents to be concerned about his symptoms.

Question: What diagnosis is suggested by this history?
**Answer:** The history suggests musculoskeletal and chest wall pain due to overzealous physical activity.

**PHYSICAL SIGNS**

a. **GENERAL APPEARANCE** - Normal right-handed 16-year-old male holding his arm close to his body in an effort to avoid pain. The shoulder and right pectoral area are tender and their manipulation exactly reproduces his pain.

Proceed
b. **VENOUS PULSE** - Central venous pressure estimated at 4 cm H$_2$O.

**Question:** How do you interpret the venous pulse?
**Answer:** The venous pulse is normal in mean central venous pressure (CVP) and wave form. It is best evaluated by observing the internal jugular veins that lie deep to the sternocleidomastoid muscle.

The normal mean CVP is less than 7 cm of H$_2$O. Since the sternal angle is about 5 cm higher than the mid-right atrium (which is the arbitrary zero reference point), the neck veins should not pulsate to a level exceeding about 2 cm higher than the sternal angle.

The normal venous waves include:

- The “a” wave due to atrial contraction.
- The “x” descent due to atrial relaxation and systolic descent of the tricuspid valve.
- The “c” wave (more often recorded than seen) partly transmitted from the carotid artery and partly due to the billowing of the tricuspid valve.
- The “v” wave due to passive filling of the right atrium.
- The “y” descent due to emptying of the right atrium after the tricuspid valve opens.

**Proceed**
c. ARTERIAL PULSE - (BP = 120 / 70 mm Hg)

**Question:** How do you interpret the carotid arterial pulse?
**Answer:** The arterial pulse is normal. This is best assessed by gentle palpation of the carotid just medial to the sternocleidomastoid muscle to exclude three general categories of abnormality: hypokinetic, hyperkinetic and twice beating.

d. PRECORDIAL MOVEMENT

**Question:** How do you interpret this apexcardiogram?
**Answer:** The apexcardiogram is normal, i.e., a brief impulse occurs in early systole.

Impulses of different character and in different locations than the normal brief apical impulse located in the fifth intercostal space at the midclavicular line are found in a variety of disease states.

**Proceed**
Question: What are the two audible components of the first heart sound at the lower left sternal edge?
**Answer:** Normal splitting of the first sound due to mitral and tricuspid closure respectively is best heard at the lower left sternal edge. The mitral component is best heard at the apex, but in many normal patients is intense enough to also be heard over the area where tricuspid closure is best heard.

e. **CARDIAC AUSCULTATION (continued)**

![Cardiac auscultation diagram](image)

**Question:** Why is the second sound split in inspiration?
Answer: During inspiration the chest expands and intrathoracic pressure drops, favoring greater venous return to the right ventricle, pooling of blood in the lungs, and less return to the left ventricle. The increase in right ventricular volume prolongs right-sided ejection time and the decrease in left ventricular volume reduces left-sided ejection time. Additionally, an inspiratory increase in pulmonary vascular compliance may result in an inertial delay of P2 ("hang-out"). The net effect of inspiration is to cause the pulmonary valve to close later (P2) and the aortic valve earlier (A2), i.e., normal inspiratory splitting of the second heart sounds.

e. CARDIAC AUSCULTATION (continued)

Question: How do you interpret the heart sound marked by the arrow?
**Answer:** The arrow marks the third heart sound (S3). After the mitral valve opens in diastole, blood accelerates into the ventricle during the rapid filling phase. The cardiohemic system (e.g., valve apparatus, ventricular wall, blood) generates low frequency vibrations, causing the S3. The sound is low in frequency and occurs about .16 sec. after A2. Children and young adults often have normal or “physiologic” third heart sounds.

**Questions:**

1. **Under what pathologic circumstances may third heart sounds occur in older patients?**

2. **What other filling sound not observed in this patient may occur?**
Answers:

1. Pathologic third sounds may occur if blood rapidly accelerates into the ventricle because of: 1) an increased volume of flow, e.g., in mitral regurgitation or certain shunt lesions, and 2) a high cardiac output state, e.g., in hyperthyroidism. They also commonly occur if blood entering the ventricle decelerates rapidly because of a stiff non-compliant ventricular wall, i.e., ventricular failure.

2. A pathologic fourth heart sound (S4) as shown below.

![Diagram of heart sounds](image)

**Question:** What is the cause of an S4?
Answer: At the end of diastole (presystole) atrial contraction occurs, causing rapid blood flow into the ventricles. If the ventricle is less compliant than normal, rapid deceleration of blood occurs and causes low frequency vibrations analogous to those occurring with an S3.

f. PULMONARY AUSCULTATION

Question:

How do you interpret the acoustic events in the pulmonary lung fields?
**Answer:** In all lung fields, there are normal vesicular breath sounds.

**ELECTROCARDIOGRAM**

![ECG Diagram]

**Question:** How do you interpret this ECG?
Answer: The ECG is normal.

CHEST X RAYS

Questions:
1. How do you interpret these X rays?
2. Based on the history, physical examination, ECG and chest X rays, what is your diagnosis and plan to further evaluate this patient?
**Answers:**

1. The chest X rays are normal.

2. The history and examination are consistent with musculoskeletal chest wall and shoulder pain due to excessive exercise. His cardiac evaluation is entirely normal. Routine screening laboratory work including blood count and urinalysis were normal. While no further evaluation is indicated, a diagrammatic illustration of the timing of the acoustic events discussed related to hemodynamic study of the left heart pressure follows.

**Proceed**
**LABORATORY**

\[ S_4 \] FOURTH HEART SOUND

\[ M_1 \] MITRAL VALVE CLOSURE SOUND

\[ T_1 \] TRICUSPID VALVE CLOSURE SOUND

\[ A_2 \] AORTIC CLOSURE SOUND

\[ P_2 \] PULMONIC CLOSURE SOUND

\[ S_3 \] THIRD HEART SOUND

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**Proceed for Explanation**
EVENTS OF THE CARDIAC CYCLE: The first phase of ventricular systole, isovolumic contraction, begins with the abrupt rise in left ventricular pressure and is associated with the initial, mitral component (M1) of the first heart sound. The succeeding rapid ventricular ejection phase begins with the opening of the aortic valve and a rise in aortic pressure. This is followed by the phase of reduced ejection, which ends just prior to the incisura on the aortic pressure tracing.

The onset of left ventricular isovolumic relaxation, which begins diastole, is usually identified with the incisura and the aortic component of the second heart sound (A2), whereas rapid ventricular filling begins when the left ventricular pressure falls below left atrial pressure. An S3 sound may occur at the end of this phase. The subsequent phase of slow ventricular filling is followed by atrial systole during which an S4 sound may occur.

Question: How would you treat this patient?
Answer: Simple treatment with local heat, mild analgesics and especially local rest (i.e., stopping tennis for several days) resulted in resolution of the patient’s symptoms. His parents were reassured that there was no evidence of the heart disease which caused his father’s heart attack. Because of the family history, however, they were advised that their son should periodically have his “coronary risks factors” checked during his young adulthood (e.g., blood pressure, serum lipids, blood sugar). He was encouraged to continue exercise in moderation, avoid excess dietary fats and calories and smoking.

Proceed for Summary
SUMMARY

The judgment that this patient’s cardiovascular status is normal is based on a simple but orderly method of bedside diagnosis. The clinician, armed only with his senses and an organized system for evaluation, can predict the patient’s anatomy and physiology with great accuracy. The “five finger” approach of Drs. Harvey and Perloff cannot be improved upon, and should be followed in the cardiovascular evaluation of all patients.

Proceed
THE FIVE FINGERS OF CLINICAL DIAGNOSIS

HISTORY

PHYSICAL SIGNS

ECG

X RAY

DIAGNOSTIC LABORATORY

Proceed
THE FIVE FINGERS OF PHYSICAL SIGNS

PHYSICAL APPEARANCE

VENOUS PULSE

ARTERIAL PULSE

PRECORDIAL MOVEMENT

AUSCULTATION

Proceed
By using his/her senses and an orderly approach, the examiner is able to correlate his/her bedside observations with:

1. The physiological events of the cardiac cycle as shown in the hemodynamic laboratory study presented for this patient.

2. A basic knowledge of cardiac anatomy as shown in the following specimen.

Proceed
Specimen from 22-year-old accident victim. Coronal section with pulmonary outflow tract, anterior ventricles and aorta cut away.
To Review This Normal Patient:

The **HISTORY** is typical of musculoskeletal chest wall pain.

On **PHYSICAL EXAMINATION**:

a. The **GENERAL APPEARANCE** reflects the patient’s chest wall pain.

b. The **JUGULAR VENOUS PULSE** mean venous pressure is normal at 4 cm H$_2$O (normal = < 7cm H$_2$O). The wave form is normal with a dominant “a” wave due to atrial contraction.

c. The **CAROTID PULSE** is normal in upstroke, peak, and downstroke.

d. **PRECORDIAL MOVEMENT** reveals a normal brief apical impulse in the fifth intercostal space at the midclavicular line, occurring at the time of the first heart sound.

Proceed
e. **CARDIAC AUSCULTATION** reveals normal splitting of the first sound at the lower left sternal edge of .03 seconds. There is also normal inspiratory splitting of the second heart sound at the upper left sternal edge of .06 seconds. A physiologic third sound is heard at the apex. It is judged as normal and not pathologic by the “company it keeps,” i.e., the patient’s youth and the fact that all other findings on examination are normal.

f. **PULMONARY AUSCULTATION** reveals normal vesicular breath sounds in all lung fields.

The **ELECTROCARDIOGRAM** and **CHEST X RAYS** are normal.

No **LABORATORY STUDY** is necessary.

The **TREATMENT** is directed at local pain and reassurance.