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Review Article

THE PHYSIOLOGICAL ASPECT OF CARDIAC CYCLE: A REVIEW

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Abstract

In day today era, Heart failure is becoming a very common disorder affecting large no of people. The human body is an incredibly complex machine, maintains important physiological parameters such as temperature, blood pressure, Cardiac output, pH, Blood sugar levels in narrow ranges. An important parameter that must be kept within the normal range for biological health is Cardiac output. In response to certain situations of heart failure, a series of actions take place in the body that decrease cardiac output. Heart failure in adults most frequently results from the inability of the left ventricle to fill or eject the blood. It is vital to understand these actions and why it takes place. As Ayurveda, science of life focus on prevention of disease compare to treatment, so in case of treatment of it becomes crucial to know normal physiology of cardiac cycle. This article highlight the summery based on the physiology of cardiac cycle.

Keywords: Ayurveda; Cardiac cycle; pH; Cardiac output.

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INTRODUCTION

In day today era, Heart failure is becoming a very common disorder affecting large no of people. Heart failure in adults most frequently results from the inability of the left ventricle to fill or eject the blood. The human body is an incredibly complex machine, maintains important physiological parameters such as temperature, blood pressure, pH, Cardiac output, Blood sugar levels in narrow ranges. An important parameter that must be kept within the normal range for biological health is Cardiac output.

Every cell in our body requires a constant supply of nutrients, such as glucose oxygen etc as well as removal of waste products such as CO2 to prevent a toxic build up.

To maintain this constant exchange of material, we rely on blood to circulate in the transport network of blood vessels and interact with cells in organs and tissues. If this does not occur at a sufficient rate cells suffer hypoxia, lack of energy substrates and toxic effects of metabolic waste build up.

Heart failure may thus be defined as the pathological state in which the heart is unable to pump blood at a rate required by the metabolizing tissues. Therefore, it is obviously crucial to maintain blood flow at a sufficient rate through the systemic tissues and lungs. This is achieved by maintaining the pumping action of heart.[1]

This can be easily understood by Diagram 1.

AIMS AND OBJECTIVES

To study the concept of Cardiac cycle in detail.

To study physiology of Cardiac cycle as well as to point out the main affections after a failure of this cycle.

MATERIALS & METHODS

Since the present study is a literary research, different opinion available in Modern Physiology texts on cardiac cycle with special reference to physiology of cardiac cycle are compiled here.

CONCEPTUAL STUDY

The sequence of changes in the pressure and flow in the heart chambers and blood vessels in between the two subsequent cardiac contractions is known as cardiac cycle.

The cyclical repetition of various coordinated events (Electrical events as well as mechanical events) in heart, from beat to beat is called cardiac cycle.

Cardiac cycle time

At a heart rate of 75/min, an individual cardiac cycle lasts for 0.8 seconds.

During an individual cardiac cycle, each side of the heart, the right heart (Rt. Atrium +Rt. Ventricle), the left heart (Lt. Atrium +Lt. Ventricle) receives the blood from the corresponding venous system and pumps out into the corresponding arterial system. These events recur cyclically until death of the individual.

Events of cardiac cycle: These are,

1. Atrial events

Atrial systole 0.1 second.
Atrial diastole 0.7second.

2. Ventricular events

Ventricular systole 0.3 second.
Ventricular diastole 0.5 second.

When, there is tachycardia, the time occupied by the cardiac cycle is shortened.

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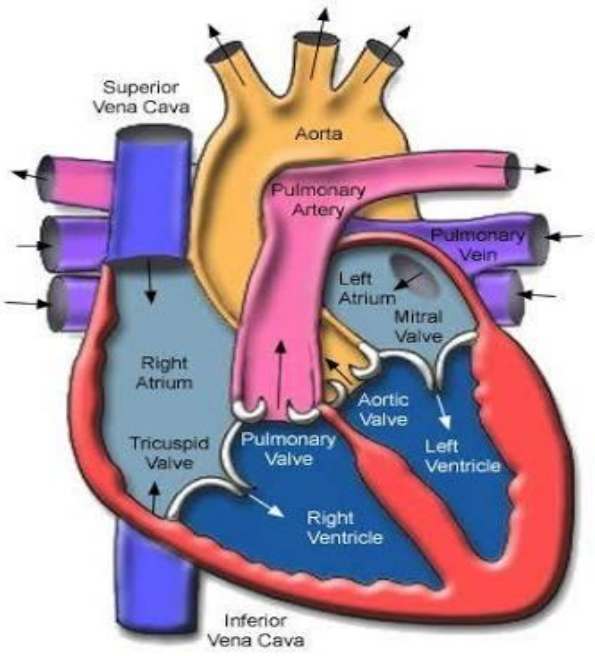
Diagram 1: Heart function



This shortening however occurs on the cost of diastole but the systole is only little affected.

Phases of cardiac cycle

i. Isovolumetric contraction.
ii. Phase of rapid ejection.
iii. Phase of reduced ejection.
iv. Protodiastolic phase of the ventricles.
v. Isovolumetric phase of relaxation of the ventricle.
vi. Rapid filling phase of ventricles.
vii. Reduced filling phase of ventricle (Diastasis).
viii. Last rapid filling phase of ventricle (Atrial systole)

Isovolumetric contraction

Iso – same.
Volume –volume.
Metros – Length.

In this phase, the volume of the ventricle that is length of individual myocardial cell remains same because intra-ventricular blood does not permit shortening of the muscle. So this phase is known as isovolumetric contraction.

Duration: 0.05 seconds.

In the beginning: Semilunar valves are closed.

AV valves are still not firmly closed.
Intra ventricular pressure is nearly o mm Hg.

In the middle: Contraction starts.
Intra ventricular pressure rises steeply. ie< 80mm Hg.

In the end: Intraventricular pressure just exceeds the diastolic pressure in the aorta ie> 80mm. Hg.

The AV valves close firmly and sharply in this phase so first heart sound produces in this phase.

The latter half of the R wave of ECG coincides in this phase.

Phase of rapid ejection

In this phase, ventricular ejection is very rapid, & a large amount of blood is rapidly ejected from the ventricle, so this phase is known as phase of rapid ejection.

Duration 0.10 seconds.

In the beginning: Intraventricular pressure exceeds the hydrostatic pressure of the aorta.
Semilunar valves open.

Ventricular ejection starts.

In the middle: Ventricular ejection continues and it is very rapid.

Intraventricular pressure starts decreasing.
Aortic pressure starts increasing.

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In the end: Aortic pressure rises steeply, but remains a trifle lower than that of ventricle.

The volume of the ventricle undergoes remarkable and rapid reduction in this phase.

The ST segment of the ECG occurs in this time.

Phase of reduced ejection

In this phase, the rate of ventricular ejection falls and the total blood ejected is less than that in rapid ejection phase. So this is known as phase of reduced ejection.

Duration 0.15 seconds.

In the beginning: Aortic pressure remains a trifle lower than that of ventricle.

In the middle: Ventricular pressure also falls but still little more than that of Aortic Pressure.

In the end: Intraventricular pressure falls below the aortic pressure.

The ventricular volume begins to level off.
This phase coincides with T wave of ECG.

Protodiastole

Protodiastole is the first stage of ventricular diastole, hence the name protodiastole.
Duration 0.04 seconds.

In the beginning: Intraventricular pressure begins to fall sharply below that of aorta but the semilunar valves are still open.

In the middle: Column of blood in aorta (or pulmonary artery for right ventricle) tries to fall into the ventricle, hitting on its way the semilunar valves.

In the end: Closure of semi lunar valves, with a bang (Producing 2nd heart sound).

The protodiastole indicates only the end of systole and beginning of diastole.

Isovolumetric relaxation of the ventricle

In this phase, both the ventricles relax as closed cavities without any change in volume or length of the muscle fiber. So this phase is known as isovolumetric relaxation of ventricle.
Duration 0.06 second.

In the beginning: Closure of semilunar valves.
AV valves are still closed.
Ventricles start relaxing.

In the middle: Ventricle is actively relaxing.
Ventricular pressure falls very sharply.

In the end: Ventricular pressure goes below the atrial pressure = 0 mmHg.
AV Valves open

The 2nd heart sound which is due to closure of semilunar valves occurs at the end of the protodiastolic period.

Rapid Filling phase

Due to opening of AV valves, blood flows from the atrium to the ventricle with a gush. About 70% of filling takes place during this phase so, this phase is called the first rapid filling phase.

Duration 0.10 seconds.

In the beginning: AV valve open.

Blood flows from the atrium to ventricle.

In the Middle: Due to filling of ventricle, the volume of the ventricle rises steeply.
Atrial pressure falls slightly.

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In the end: The atrial pressure still remains little more than that of the ventricle so flow continues.

Rushing of blood into ventricles during this phase causes production of third heart sound.

Reduced filling phase (Diastasis)

After the end of rapid filling phase, the ventricular inflow slows down, so this is known as reduced filling phase.
Duration 0.20 seconds.

In the beginning: The atrial pressure still remains little more than that of the ventricle.
Ventricular inflow continues but slows down.

In the end: Ventricular volume continues to increase.

About 20% of filling occurs in this phase.
In ECG, this phase mostly corresponds with the phase which is in between the end of T wave and next P wave.

Last rapid filling phase (Atrial systole)

The phase, which follows the diastasis, known as last rapid filling phase. After reduced filling phase, the artia contract and push a small amount of blood into ventricles so this phase is also called atrial systole or atrial kick.
Duration 0.10 seconds.

About 10% of ventricular filling occurs in this phase.

This phase coincides with the 4th heart sound of the phonocardiographic tracing. The P wave of ECG begins slightly before the atrial contraction.[2][3]

RESULT AND DISCUSSION

Regulation of the circulatory system to maintain pumping action of heart is critical in ensuring adequate perfusion to meet metabolic requirement of tissues.

This is the essence of homeostasis i.e. maintaining pumping action of blood is crucial to ensure that all tissues are adequately perfused.

Heart failure in adults most frequently results from the inability of the left ventricle to fill or eject the blood. The severity of heart failure and its prognosis are more closely related to the degree of diastolic filling abnormalities than the ejection fraction. This underscores the importance of understanding the mechanisms of diastolic abnormalities in heart failure.

CONCLUSION

Cardiac cycle is a vital bodily function and one need to understand its anatomy and physiology to assess the risks of heart failure. The heart is a vital organ to stay alive, similar mechanical pumps are invented and built to play the role of the heart in patients, but no mechanical pump can perform the role of the heart in a 100% satisfactory and long lasting way. As much as we know about heart physiology more chance we have to discover to avoid heart pathology.

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