INTRODUCTION

The cardiac cycle is an important concept presented in human anatomy and physiology courses. At Kingsborough Community College, all Allied Health majors taking Anatomy & Physiology must understand the cardiac cycle to grasp more advanced concepts. Contemporary textbooks (6, 7, 14) illustrate the cardiac cycle’s concurrent events via linear models with overlapping line segments as physiological readouts. This presentation is appropriate for reference but, in the interactive classroom the promotion of understanding through clear, concise visual cues is essential (1). Muzio and Pilchman created a diagram to summarize events of the cardiac cycle (13). After discussions with one of the authors, I modified the diagram to aid visualization of the cycle and emphasize it as a repetitive, continuous process. A flow diagram presenting the portions of the cycle individually and progressively was also constructed. Three labeled phases are made from the diagram, based on grouped events occurring at different points. The simple, compartmentalized, cyclical diagram presented here promotes understanding of the cardiac cycle visually (15).

PROCEDURE

A healthy, adult human heart receives blood at the right atrium from the superior and inferior vena cava. The left atrium receives blood from the lungs via pulmonary veins. The chambers contract simultaneously (atrial systole), forcing blood into the right and left ventricles (RV and LV), respectively, and this activity is triggered by atrial depolarization (P-wave on the electrocardiogram (ECG)). The atria then relax while ventricular systole (VS) begins, initiated by ventricular depolarization (QRS complex on an ECG). During VS, the RV forces blood into the pulmonary trunk while the LV forces blood into the aorta. The atrioventricular (AV) valves, known as the tricuspid (right) and mitral (left) valves, shut from pressure within the ventricles. When VS ends, the pulmonary and aortic semilunar (SL) valves close, preventing blood from re-entering the chambers. This simple explanation of the circulatory pathway within the heart is enough to allow students to understand a cyclical cardiac cycle diagram.

The normal resting heart rate averages 72 beats per minute (bpm). The proposed diagram employs a heart rate of 75 bpm, each cycle 0.8 sec in duration (Fig. 1). It consists of four color-coded concentric circles. The outermost layer represents atrial (A) activity; the second, the ventricles (V); the third, the AV valves; and the AD = atrial diastole; AS = atrial systole; VD = ventricular diastole; VS = ventricular systole; AVC = atrioventricular valves close; AVO = atrioventricular valves open; SLC = semilunar valves close; SLO = semilunar valves open.

FIGURE 1. Schematic cardiac cycle diagram with color coding. Four concentric circles create four distinct, color-coded layers, each representing atria (A), ventricles (V), atrioventricular valves (AV), and semilunar valves (SL), as shown. Time unit = second (s). Beginning of the cycle (0.0 s) coincides with the end of the cycle (0.8 s). At any time point or interval, the parts of the heart exhibit specific actions to mediate completion of the cycle. Activities of the four heart chambers and four heart valves can be seen through their arrangement. At 0.2 s, the AV valves snap shut, giving the first heart sound (S1). At 0.45 s, the SL valves close due to ventricular diastole, causing the second heart sound (S2).
fourth (innermost), the SL valves. The concentric circles are divided into eight equal-time intervals, each showing activity of the structure at that time interval. For example, VS occurs in the ventricular layer between 0.2 s and 0.45 s. At 0.2 s, the atria transition from systole to diastole, and the AV valves shut, preventing backflow. The ventricles return to diastole at 0.45 s, causing a drop in pressure in the chambers. Backflow of blood is prevented by SL valve closure, generating the “Dub” sound, marking the end of VS. The elastic recoil of the aorta and pulmonary trunk, together with SL valves closure, leads to an increase in pressure within these arteries and causes the dicrotic notch (incisura) (2). Loss of pressure in the ventricles causes AV valves to open, allowing blood to enter from the atria. All structures remain inactive for the rest of the cycle. The end of one cycle (0.8 s) coincides with the beginning of the next, indicating the cyclical nature of this process.

To facilitate understanding of the cardiac cycle, the diagram is divided into three segments: the first spans from the start of the cycle (0.0 s) to the end of atrial systole (0.2 s), the second coincides with VS (0.2–0.45 s), and the last starts with VD (0.45 s) and extends to the end of the cycle. During class, the first segment is shown and explained. Once attention shifts to the second segment, the first is faded out. This progression allows students to review the previous segment while highlighting current events. After the third segment is discussed, the entire diagram is shown again as a summary. Questions may follow.

Students generally learn better when concepts are organized and presented in meaningful clusters (3). The aforementioned segments of the diagram can each be molded into a logical, meaningful phase. The first segment (0.0 s–0.2 s) is designated the “atrial systolic” phase (Fig. 2). During this phase, students learn that the beginning and end of atrial systole occur within this time period. Students can understand that the ventricles are at rest, the AV valves are open, and the SL valves are closed so blood entering the ventricles should only come from the atria. The second

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**FIGURE 2. Progressive Presentation of the Cardiac Cycle Diagram.** The cardiac cycle is divided into three phases based on events occurring at certain time points. Progressive presentation of each portion of the cycle is indicated by arrows. Formerly shown portions are obscured for distinction from the currently presenting portion. When the third portion is demonstrated and explained, the complete diagram is presented in full again, providing a traditional whole-part-whole-learning approach.
segment is called the “Lub-Dub” or “ventricular systolic” phase. The closing of the AV valves, which generates the “Lub” sound due to increased pressure in the ventricles, marks the beginning of this segment, while the closing of the SL valves, which generates the “Dub” sound, marks the end. Students can then reason that the atria should be relaxed, the AV valves closed to prevent backflow of blood into the atria, and the SL valves open to allow blood to enter either the pulmonary or systemic circuits. The third (last) segment can be designated the “post-systolic” phase since atria and ventricles have completed ejection and are relaxed. In their relaxed (diastolic) state, the AV valves now open, allowing blood to drain into the ventricles, with the SL valves closed to keep blood in the arteries from entering the ventricles.

CONCLUSION

This cardiac cycle teaching tool provides students with a logical sequence of events to enhance understanding and recall of the concepts involved. The tool is more successful when used after a discussion of cardiac physiology and an explanation of how to use the visual tools. A former study shows that a clear and informative illustration, coupled with verbal cues, elicits the most effective learning (8, 16). The inherent nature of the phasic dissection may shape the way students approach other physiological processes, such as gas exchange (3, 15). Since the cardiovascular system is considered early in the semester, simplifying the cardiac cycle can ease students into later subject matters. When asked their opinion of the cyclical diagram, students expressed appreciation for its simplicity and thoroughness. However, many indicated that detailed explanation on the diagram’s logic, as well as the phasic division, was equally important. After presentation of the diagram, students asked many questions, suggesting meaningful learning is occurring (9, 10, 11).

Instructors can add graphics to the diagram, as desired. However, employ prudence when making modifications. Too much flare may ruin the ease of comprehension (4). The proposed model may further facilitate a deeper look at the cardiac cycle (12). Additionally, a heart model can be easily constructed by students and used in conjunction with this simple diagram (5). The two approaches may complement each other to foster critical thinking.

ACKNOWLEDGMENTS

The following article does not contain any conflict of interest to any individual. The author shown on title page is the sole author of this article. The content of this article requires no sponsorship of study. The author wants to thank Drs. Peter Pilchman, Mary Ortiz, and Loretta Taras for their valuable input and support.

REFERENCES