Common Cardiac Arrhythmias

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Introduction

- Interpretation of cardiac arrhythmias plays vital role in diagnosis of cardiac disorders
- Important for health care workers in emergency care to understand principles of cardiac monitoring
- Understanding of physiology of CV system, it is possible to identify arrhythmias and explain their effects
- This should lead to early detection of signs and symptoms, accurate diagnosis, and provision of appropriate treatment

Anatomy and Physiology

- Heart is a small, muscular organ, roughly size of your fist
- Located in thoracic cavity, immediately above diaphragm and between lungs
- Beats average 70 bpm, pumps more than 6,500 L of blood throughout day
- 2 main functions:
    - Circulate oxygenated blood to tissues via high pressure arterial circulation
    - Pump deoxygenated blood to lungs through low pressure venous circulation
- Heart consists of four chambers, left and right atria and the left and right ventricle
- Atria smaller than ventricles and have thinner walls
    - atria serve as low pressure storage chambers rather than pumps
- Ventricles propel blood through pulmonary and systemic circulations and must be strong enough to overcome resistance
- Cardiac cycle – period from end of one heartbeat to the end of the next
- Heart contracts (systole) and then relaxes (diastole)
- Average heart rate of 70 bpm, each cardiac cycle lasts 0.8 seconds, with relaxation stage (0.5 seconds) slightly longer than contraction
- Action of heart valves important in maintaining cardiac function
- If valves become incompetent, leads to increased cardiac workload and decrease in efficiency, which if left untreated can lead to heart failure
    - Mitral and aortic valves most commonly affected
- Wall of the heart another important factor
    - Consists of three distinct layers: Endocardium (inner), Myocardium (middle), and pericardium (outer).
    - Endocardium made of endothelial tissue and lines the heart and also covers the valves
        - Also forms lining of vessels entering and leaving the heart
        - Smoothness of this tissue ensures smooth flow of blood and prevents turbulent flow
    - Myocardium made of highly specialized cardiac muscle, which allows generation of action potentials

        - Dependent on oxygen for its energy requirement, and performance seriously impaired by oxygen deficiency
        - Thickest in the ventricles, where sufficient force must be produced to pump blood
        - The more the ventricle fills with blood, the further the muscle fibres are stretched, the greater force of contraction, and greater volume of blood ejected (Starling's Law of Heart)
        - In patients with heart failure or poor ventricular function, CO is compromised with increased volume in ventricle
            - Can result in inadequate pumping and pooling of blood in pulmonary and peripheral vasculature
    - Outer pericardium provides fibrous covering around heart, holds in fixed position in thorax, and provides physical protection and barrier to infection
        - Consists of tough outer fibrous layer and thin inner serous layer
        - Fibrous layer is highly resistant to distension
        - Inner serous layer consists of visceral and parietal layers
        - Visceral layer (a.k.a. epicardium) covers heart and great vessels and lines fibrous pericardium
        - Between parietal and visceral layer is potential space called pericardial cavity which contains fluid
- Heart requires good blood supply to function effectively
- Knowledge of coronary circulation is essential
- Myocardium receives blood from left and right coronary arteries, which are from first branches of aorta
- Heart receives about 250 mL of blood per minute, with myocardial cells pulling more oxygen from blood than any other organ
- Most of blood received in myocardium during diastole

Cardiac Conduction

- Comprises sinoatrial node (SA), atrioventricular (AV) node, bundle of His, left and right bundle branches, and Purkinje fibres
- Electrical activity of heart can be examined by electrocardiogram (ECG)
- Impulse initiated in SA node
    - These cells are autorhythmic – ability to generate action potential spontaneously
- SA node sets HR and known as the pacemaker
- From SA node, current conducted across atrial myocardium in radiating pattern, causing atria to contract (atrial systole)
    - This produces the P wave on the ECG
- After flowing through atria, electrical impulse reaches AV node, low in right atrium
- Conduction delayed slightly to allow time for atria to fully contract
    - This conduction time is noted as the P-R interval
- Impulse then enters ventricular septum and bundle of His, which divides into right and left bundle branches

- Bundle branches terminate in finely branched Purkinje fibres embedded in ventricular myocardium
- Rapid conduction of impulse across ventricles results in ventricular systole
    - Depolarization indicated by QRS complex on ECG
- ST segment is transient period where no electrical current can be passed
    - Measured from end of S wave to beginning of T wave
- T wave is a representation of ventricles relaxing
- Cells of the AV node pace the heart at 40-60 bpm
- SA node has ability to generate fastest rate, and usually remains in control
- In SA node disease, a latent pacemaker will generate an escape rhythm
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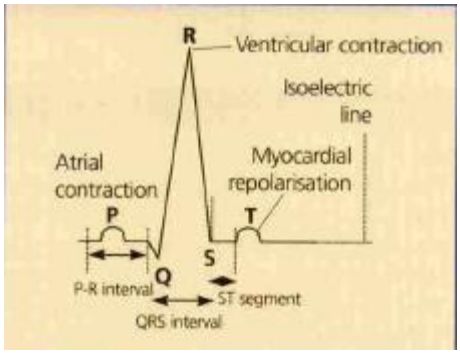


Sinus Rhythm

- P wave (spread of electrical depolarization through atria) lasts less than 0.11 s
- P-R interval (beginning of P wave to beginning of QRS complex) normally takes between 0.12s to 0.21s
- Q wave is the first negative deflection in complex
- R wave is first positive deflection
- S wave is negative deflection that follows
- Sinus rhythm defined as being a rate between 60-100 beats per mijnute
- Heart beat is regular and complexes identical

Assessing a Rhythm Strip

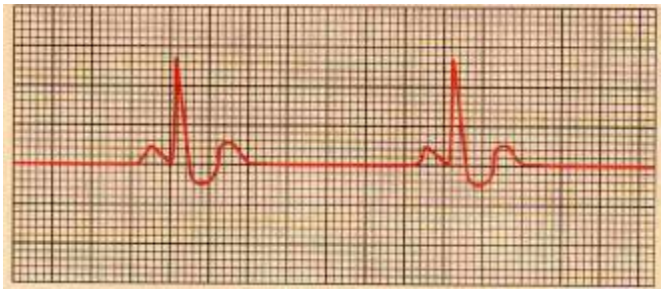
- Displays and printouts from cardiac monitors only suitable for rhythm recognition and NOT diagnosis of MI

- 12-lead ECG should be performed which contains additional information

Disorders of Impulse Formation

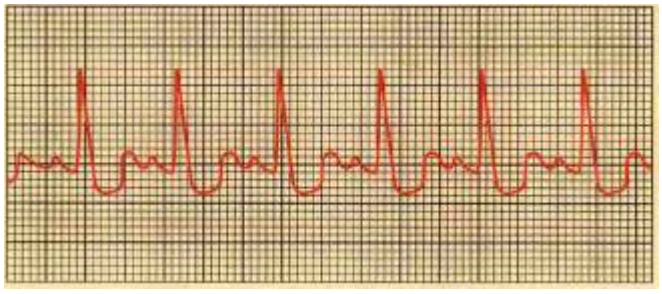
Sinus Bradycardia

- Regular and originates in SA node, but the SA node discharges impulses at rate of less than 60 bpm
- Can be found in athletes and possibly during sleep
- Slow heart rate might be helpful in certain patients – such as those with MI
- Slow heart rates tolerable in people with healthy hearts
- Severe heart disease, the heart may not be able to increase SV to compensate for slow rate
    - Treatment required if patient becomes symptomatic
    - Symptoms include light headedness, fainting, chest pain, hypotension, dyspnea



Sinus Tachycardia

- Heart rate is between 100-180 bpm due to excessive discharge from SA node as result of vagus nerve inhibition, or sympathetic stimulation, or both
- All other ECG characteristics are the same as in Sinus Rhythm
- Usual response to stressors
- Because heart is beating faster, amount of time between contractions reduced, thus, ventricles don't have sufficient time to fill, and CO falls
- Often a sign of underlying problem that requires investigation



Sinus Arrhythmia

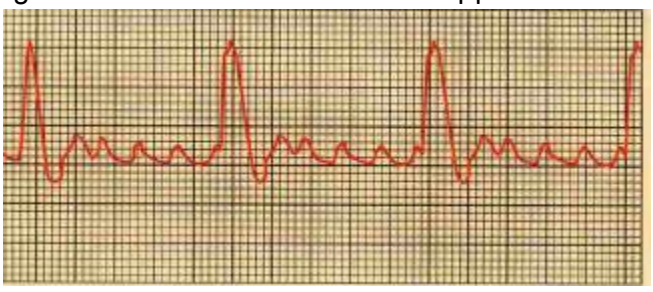
- Accepted phenomenon in young people caused by variations in parasympathetic activity on SA node during respiration
- Impulses originate in SA node, but the rate at which impulses appear varies

Atrial Fibrillation

- Can be permanent or paroxysmal
- Rapid chaotic depolarization of impulses, occurring throughout the atrial myocardium, replacing normal rhythmic activity in SA node
- Every minute 400-600 impulses reach the AV node form different atrial foci rather than the SA node, but only 120-180 of these will reach the ventricles to produce QRS
- Transmission of atrial impulses through AV node is erratic, making ventricular rhythm irregular
- Fast pace at which atria depolarize leads to failure of atria to contract effectively, causing them to quiver
- Patients often present with palpitations or symptoms of underlying cause
- If AF persists for more than 48 hours, stasis of blood in fibrillating atrium can lead to blood clot formation and systemic embolism
- Aim of treatment is to control ventricular rate, thereby optimizing cardiac function, reducing risk of embolism

Atrial Flutter

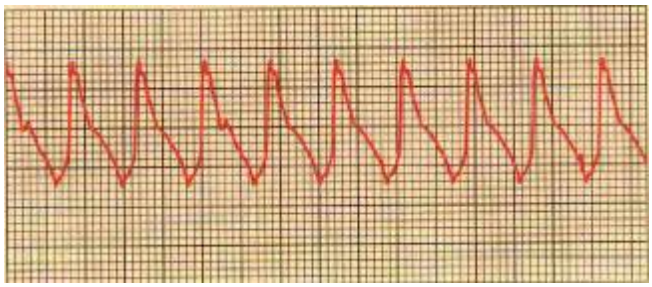
- Much less common than AF
- Almost always associated with underlying significant cardiac abnormalities
- Occurs when a single abnormal focus in atria discharges regularly at a rate of 250-350 per minute
- AV node unable to transmit all impulses, and usually a degree of AV block, as node acts as a gatekeeper
- Rapid atrial rate gives a characteristic ‘saw tooth’ appearance in the ECG



Ventricular Tachycardia

- Occurs when three or more ventricular extrasystoles occur in sequence

- Duration of V Tach varies from a few beats to many hours
- Often preceded by ectopic beats and evolves from a ventricular focus in right or left ventricle that depolarizes with a rate of 140-220 per minute
- Typically, beats that originate in ventricles produce wide QRS complexes
- P waves often buried in previous QRS
- P-R interval also unidentifiable
- Occurs in patients with organic heart disease
- Can quickly lead to heart failure and shock with pulmonary edema



Ventricular Fibrillation

- Rhythm of cardiac arrest
- occurs when parts of the ventricular myocardium depolarize in chaotic manner, independently of each other
- Co-ordinated ventricular activity and muscular contraction ceases
- Irregular, chaotic and abnormal deflections of varying height and width are evident on ECG
- Coarse or fine, depending on appearance
- Baseline is irregular without any identifiable QRS
- Heart ceases to pump and after approximately ten seconds the BP drops and unconsciousness occurs
- If untreated, death will follow after three to five minutes
- Most common cause of sudden cardiac death

Disorders of Impulse Control

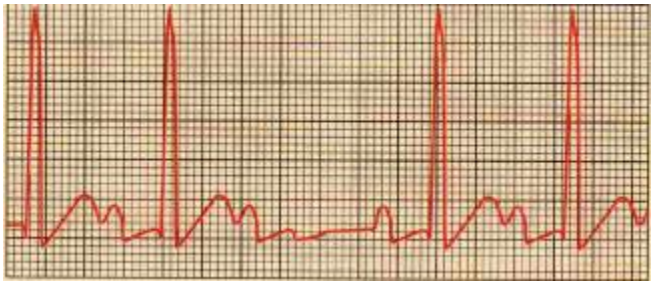
- Characterized by a delay or failure in impulse conduction from atria to ventricles
- Occurs on three levels

First-Degree AV Block

- Atrial conduction is prolonged
- Impulse is delayed passing through the AV node to ventricles, resulting in prolonged P-R interval
- QRS complex follows every P wave and rhythm is regular
- Prolonged conduction time frequently found in athletes and older people

Second-Degree Heart Block

- Two types of second degree heart block
    - Mobitz Type 1
        - occurs when progressive increase in conduction time over several beats
        - Phenomenon repeats itself with a gradual prolonging of PR interval over 3-6 beats until an impulse is totally blocked, and P wave occurs without corresponding QRS
        - QRS irregular and often slow
        - Usually localized to Av node



    - Mobitz Type 2
        - Characterized by an occasional fdropped QRS complex without a preceding lengthening of P-R interval
        - Dropped beat can occur irregularly or regular

Third Degree AV Block

- Complete heart block
- Characterized by a complete or permanent cessation of AV conduction so that all impulses frm above the AV junction are blocked
- Most cases, pacemaker function taken over by a focus below the block, heartbeat can then be sustained by impulses from area around AV node, or ventricles
- Nodal rhythm gives a rate of around 40-60 beats, while ventricular rhythm gives 30-40 bpm
- If this escape rhythm does not develop, ventricular standstill will occur and fatal if not treated
- Atrial rate might be normal and regular, and ventricular rate might also be regular, but impulse transmission between the atria and ventricles is absent
- P wave does not preceded a QRS complex on ECG

Conclusion

- With a better understanding of physiology of heart and electrical conduction system, the cardiac arrhythmias can be better understood
- Effective patient care and intervention depends on accurate assessment, observation, and recognition

Summary

- Cardiac arrhythmias are quite complex and difficult to understand, but breaking down the anatomy, physiology, and electrical conduction of the heart, allows us to understand them better
- A good understanding of the cardiac arrhythmias and the ability to recognize these rhythms on a monitor can increase the efficiency to which we treat such problems
- As dental professionals, it is important that we understand the rhythms and their characteristics in order to identify these quickly and be able to inform the attending team upon arrival

Reference

Hand, H. *Common Cardiac Arrhythmias*. **(2002)**. Emergency Nurse. **10:** 3, 29-38.