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Essay

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Electrocardiography patterns of snake envenomations

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Abstract

Snakebite envenomation constitutes a neglected tropical disease of public health importance. This is evident by over five million persons per year especially young farmers being bitten by snakes in rural areas. Hence, equally making snakebites an occupational disease. Snake envenomation leads to several toxic syndromes including cardiac toxicity. The latter may lead to potentially fatal effects on the heart´s electrical conductivity resulting in lethal cardiac arrhythmias, myocardial infarctions, heart failure and talk less of cardiac arrest which have been less described. This article aims to describe the electrocardiography dysfunctions caused by snake envenomation to improve the management of snake envenomed patients through early detection, treatment and management of these snake envenomation electrocardiography-related complications.

Essay

Snake envenomation and public health implications: recognized by WHO as a Neglected Tropical Disease in 2017, Snakebite and its envenomation constitute a major public health concern worldwide [1]. Globally, each year, 4.5-5.4 million people are victims of snakebites, 1.8-2.7 million cases of snake envenomation occur and, 81,000-138,000 patients have a fatal outcome [2,3]. Snakebite disproportionately affects rural regions like sub-Saharan Africa (SSA), Asia and Latin America [4]. In SSA, 95% of snakebites and 97% of snakebite-related deaths occur [5] among young male farmers in rural areas during agricultural activity [6], hence, also making snakebite an occupational hazard [7]. Snakebite incidence is reported at over five million cases per year in SSA in general [5], and at 200 snakebites per 100,000 persons [6] and 665 per 100, 000 inhabitants [8] in some regions SSA countries. Survivals of snake envenomation may sustain lifelong physical disabilities such as blindness, extensive scarring and contractures, restricted mobility, limb amputation due to as venom-induced limb necrosis or gangrene [10,11]. The public health challenges associated with snakebites in SSA are further compounded by suboptimal disease surveillance, poor health-seeking behaviours of snake-bitten victims with 50-90% patients having a preference for alternative and complementary medicine as first-line treatment option leading to delayed hospital presentation of snaked envenomed patients; under-production of anti-venom serum (AVS) within SSA; scarcity of AVS ; the relatively high cost of AVS ; black marketing of AVS and financial constraints of patients [7,12,13]. In an observational study that mapped venomous snakes, access to health care to populations at risk of snakebites, and availability of effective AVS, it was found that large parts of SSA and are particularly vulnerable [10]. There are 93 million people in the highest risk areas. In an effort to draw attention to the problem of venomous snakebites worldwide and to spur strategies that improved outcomes, the World Health Organization has designated snakebite envenomation as a neglected tropical disease [1].

Snake envenomation and its syndromes: snake envenomation is defined as a set of symptoms secondary to human inoculation of the toxins of a snake species present in its venom. Animal venoms are a mixture of toxic bioactive compounds and enzymes such as metalloproteinases and hemorrahgins [14]. There are several snake species worldwide. The most frequent globally are Elapidae (cobras) and Viperidae (vipers). Depending on the snake species, for instance cobras or vipers, snakebites are responsible for various envenomation syndromes such as; neurotoxic syndrome: muscular weakness, paresthesis, spreading paralysis, dysphagia, dysphasia, ptosis, mydriasis or myosis, external ophthalmoplegia, dyspnea, respiratory arrest, fasciculation, hypersalivation, agitation, somnolence and convulsions; cardiotoxic syndrome: bradycardia or tachycardia, cardiac arrhythmia, hypertension, QTS prolongation, ST-segment elevation, T-wave inversion, atrioventricular block), and myotoxicity (muscular pain, stiffness and myoglobinuria;

haematotoxic syndrome: ecchymoses, petechial haemorrhage, epistaxis, haematemesis, melaena, haematuria ;systemic syndrome: vomiting, and state of shock; cytotoxic syndrome: pain, oedema, swelling, hyperthermia and skin redness; digestive or gastrointestinal syndrome: nausea, diarrhea, abdominal distension. Neurotoxic and cardiotoxicity syndromes are often caused by cobras, while Haematotoxic syndrome is a main feature of envenomation by vipers [15]. Meanwhile systemic, cytotoxic and gastrointestinal syndromes can be seen in both envenomations due to cobras and vipers [16]. In a recent epidemiological survey carried out in Cameroon, the most common snake envenomation syndromes were cytotoxic syndromes (56%), systemic syndrome (33.3%), digestive syndromes (30%) and neurotoxic syndrome (3%) [9]. Through their cardiac toxic effects, the venoms of snakes can cause both dysfunctions in cardiac myocardial function and the electrically cardiac conductivity leading to myocarditis, cardiogenic shock, myocardial infarction, conduction disorders and cardiac arrest [11,17-22]. The cardiac toxicity may be due to the direct effects of the components of snake venoms on the heart or may be indirectly caused by hyperkalemia from rhadomyolysis and acute kidney injury secondary to snake envenomination [11,17-22].

Snake envenomation and cardiovascular complications

Clinical aspects: cardiac toxicity is a well-documented complication of envenomation [12,19-24] often caused by cobras, though some cases have been reported to be due to envenomation by vipers [12,19,23,25-27]. It occurred more frequently in individuals with underlying co-morbidities (diabetes, hypertension, ischemic heart disease, advanced age, hyperlipidemia) [25,28]. Patients with cardiac involvement may be asymptomatic or develop non-specific manifestations. Common cardiovascular clinical manifestations of snake envenomation are mainly: palpitation, tachycardia, dizziness, chest pain, hypotension, irregularly irregular rhythm, shock [12,19,25-27]. Some review revealed that myocardial infarction following snake envenomation is mostly reported in young adult males from tropical regions with no history of coronary artery risk factors [19].

Electrocardiography (ECG) dysfunction due to snake envenomation: the venom directly or indirectly causes functional changes in heart tissue physiology as well as cardiac cell death [19-24]. The various toxins in the venom target ionic channels in excitable membranes of cardiac cells or cardiac cell membranes, thereby, altering their action potentials (e.g. depolarization, repolarization, alterations in its duration) or significant changes in intracellular ions activity. These changes may lead to reversible or even irreversible life-threatening cardiac arrhythmias and eventually heart failure [20]. Myocardial infarction (MI) is a common cardiovascular finding in patients with snake envenomation. Multiple case reports of myocardial infarction following snake bites have been reported [17,22]. In a scoping review by Kariyanna et al, 65% ST-segment elevation and 10% ST-segment depression were reported as main ECG findings of MI [17]. Other ECG findings were T-wave inversion in 5%, T-wave flattening in 5% and QT prolongation in 5% [17]. Among patients with cardiac arrest following snake envenomation, 14% were due to ventricular fibrillation and 5% asystole [17]. Major Electrocardiography findings following snake envenomation could be classed into rhythm and conduction disorders.

Rhythm disorders: there are many reports describing arrhythmia induced by cobras´ envenomations [16,21]. ECG in patients with envenomation show nonspecific changes such as sinus arrest with junctional escape rhythm and retrograde P-waves with a heart rate of 40beats/min, suggestive of sinus node dysfunction, however, on the 3rd day of hospitalization for snake envenomation, a repeat ECG showed normal sinus rhythm [26]. Sinus tachycardia and sinus bradycardia have also been reported after snake envenomation [22]. T-wave inversion and sinus bradycardia are also ECG changes seen in cases of envenomation [28]. Atrial fibrillation is also a common conduction disorder seen in snake envenomation with a fast ventricular rate of 126 beats/minute which resolved 24 hours after injection of AVS [12]. However, ECG taken three hours post envenomation in some patients who do not present any cardiovascular symptoms at admission revealed new-onset atrial fibrillation (AF) which was managed successfully with amiodarone [12]. It suggests that in practice, patients may need prolonged cardiac monitoring even when the acute phase is over. Pre-existing first-degree atrioventricular block (AVB) is an independent risk factor for the development of AF in some snake envenomed patients [27].

Conduction disorders: conductions disorders following snake envenomation have rarely been described in the literature. Intermittent 2: 1 Second-degree heart block was seen in some cases of viper bite [27]. A de novo first-degree AVB has also been seen in cases of snake envenomation [28]. Also, cases of bundle branch bloc, and complete heart block have been described [20].

Management of Electrocardiography (ECG) dysfunction due to snake envenomation

General principles at the scene of the snakebite incident: initial first aids measures aimed at reducing the spread of the snake venom are indicated such as immobilizing the bitten area on the body, analgesics, wound disinfection, snake species taxonomic identification to specific AVS immunotherapy and rapid transfer of the patient to the hospital [29].

Hospital management: respiratory support by mechanical ventilation for patients with respiratory failure (neurotoxicity) [29]. Anticholinesterases using neostigmine, administer after atropine or glycopyrrolate to prevent excessive cholinergic effects [29]. Specific management for ECG dysfunctions due to snake envenomation include AVS to neutralize the snake venom and reduce ECG dysfunctions, intravenous lidocaine and amiodarone against cardiac arrhythmias and beta-blockers against AVB, AF, and ventricular fibrillation [30].

Conclusion

Electrocardiography changes are common in patients who present with snake envenomation. Screening of cardiac arrhythmia or conduction disorders in these patients particularly in those with severe envenomation could prevent death by early detection, management and adequate follow-up.

Competing interests

The authors declare no competing interests.

Authors' contributions

All the authors have read and agreed to the final manuscript.

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