ORIGINAL ARTICLE

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The importance of cardiological examination in dogs with leishmaniasis: a systematic review.

A importância dos exames cardiológicos em cães com leishmaniose: uma revisão sistemática.

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ABSTRACT: Leishmaniasis, a parasitic disease, can lead to cardiac dysfunction characterized by significant alterations in cardiac enzyme levels. Elevated enzyme concentrations indicate tissue damage and impaired cardiovascular function. This systematic review analyzed the primary cardiovascular tests used to assess changes in dogs infected with Leishmania sp. Full articles and short communications published between 2000 and 2023 that focused on cardiac enzyme measurement, leishmaniasis, echocardiography, blood pressure, and electrocardiography were included. PubMed, Sci-Hub, Google Scholar, and SciELO databases were searched, excluding conference proceedings and technical manuals. Of the 122 identified studies, 29 met the inclusion criteria. Results indicate that parasitism causes substantial changes in cardiac enzymes and hypertension is prevalent in infected dogs. Additionally, electrocardiograms frequently reveal atrioventricular blocks, while echocardiograms often show dilated heart chambers and decreased cardiac contractility in dogs with leishmaniasis.

KEYWORDS: cardiovascular, electrocardiography, echocardiography, enzymes.

RESUMO: Leishmaniose, uma doença parasitária, pode levar à disfunção cardíaca caracterizada por alterações significativas nos níveis de enzimas cardíacas. Concentrações elevadas de enzimas indicam danos nos tecidos e função cardiovascular prejudicada. Esta revisão sistemática analisou os principais testes cardiovasculares usados para avaliar alterações em cães infectados com Leishmania sp. Artigos completos e comunicações curtas publicadas entre 2000 e 2023 que se concentraram na medição de enzimas cardíacas, leishmaniose, ecocardiografia, pressão arterial e eletrocardiografia foram incluídos. Os bancos de dados PubMed, Sci-Hub, Google Scholar e SciELO foram pesquisados, excluindo anais de conferências e manuais técnicos. Dos 122 estudos identificados, 29 atenderam aos critérios de inclusão. Os resultados indicam que o parasitismo causa alterações substanciais nas enzimas cardíacas e a hipertensão é prevalente em cães infectados. Além disso, os eletrocardiogramas frequentemente revelam bloqueios atrioventriculares, enquanto os ecocardiogramas frequentemente mostram câmaras cardíacas dilatadas e diminuição da contratilidade cardíaca em cães com leishmaniose.

PALAVRAS-CHAVE: cardiovascular, eletrocardiografia; ecocardiografia, enzimas.

INTRODUCTION

Leishmaniasis, often referred to as "kala-azar," is a parasitic disease primarily affecting dogs and, less commonly, cats. It is caused by the obligate intracellular parasite *Leishmania spp.*, which is responsible for various disease forms (Pacheco, 2016). According to Soares (2014), the most prevalent Leishmania species in Brazil are *Leishmania braziliensis*, causing cutaneous leishmaniasis, and *Leishmania chagasi*, causing visceral leishmaniasis. Additionally, Oliveira and Souza (2018) identified *Leishmania infantum* as a significant causative agent, transmitted by the sand-fly *Lutzomyia longipalpis*.

Cardiac complications are common and well-documented in dogs with leishmaniasis. Studies have reported a range of cardiac manifestations in infected dogs, including myocarditis, pericarditis, arrhythmias, and congestive heart failure (Laroucau *et al.*, 2018).

Echocardiography, a dynamic and non-invasive technique, is widely used in veterinary medicine to diagnose heart conditions. This method enables indirect visualization of heart chambers to assess blood flow and cardiovascular function (Muzzi *et al.*, 2000). Electrocardiography is recommended when cardiac abnormalities are suspected (Carvalho *et al.*,

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2009). This test detects myocardial changes, such as oxygenation and electrical disturbances, and helps identify the origin of these rhythms (Soares and Larsson, 2007).

Infection with *Leishmania spp.* is believed to trigger an inflammatory response in the cardiovascular system and cardiac cells, resulting in damage to heart cells and the conduction system. Immune complex deposition and hypertension may contribute to these cardiac issues (Gomez-Ochoa *et al.*, 2019).

Blood pressure evaluation is crucial in veterinary clinical practice, especially for monitoring anesthetized or critically ill patients (Tebaldi *et al.*, 2015). It is essential to note that cardiac problems can occur in both symptomatic and asymptomatic dogs with leishmaniasis. Regular cardiac monitoring, including cardiac enzyme measurement, blood pressure assessment, echocardiography, electrocardiography, and thoracic radiography, is vital for early detection of cardiac abnormalities.

Effective prevention and treatment of leishmaniasis, combined with management of cardiac complications, are essential for improving the well-being and quality of life for affected dogs (Lopez *et al.*, 2020). This study aimed to analyse cardiovascular examinations and alterations in dogs infected with *Leishmania spp.* through a systematic literature review, considering epidemiological and etiological factors.

MATERIAL AND METHODS

This study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher *et al.*, 2009). The research involved a systematic literature review of articles published in nationally and internationally indexed journals accessible through Capes platforms.

Inclusion and Exclusion Criteria

The inclusion criteria for this study encompassed full-length articles and short communications published between 2000 and 2023 in indexed journals. These articles were required to contain relevant information on canine leishmaniasis, echocardiography, electrocardiography, cardiac enzymes, and blood pressure measurement in the context of canine cardiology. No language restrictions were applied.

Conference proceedings and technical manuals were excluded from the study. Additionally, works that were inaccessible in their entirety were eliminated. The study's methodology and the relevance of the information guided the selection of articles for further evaluation.

Information Sources and Search Strategy

Articles were identified through database searches in PubMed, Sci-Hub, Google Scholar, and SciELO using the following search terms: "canine leishmaniasis," "echocardiography in dogs with leishmaniasis," and "electrocardiography in dogs with leishmaniasis." Retrieved data was converted to BibTeX format and imported into Mendeley® software for duplicate removal. Database searches were completed in June 2023.

Study Selection and Data Extraction

A researcher independently selected studies based on title and abstract analysis, followed by a full-text review. Studies that did not meet the inclusion criteria were excluded. Relevant data, including the association between parasitism and cardiac alterations, animal species, breeds, clinical signs, and diagnostic methods, were collected and documented.

Data Analysis

Data analysis involved a descriptive analysis of relevant information extracted from the studies. This systematic review aimed to analyze and synthesize the available literature on cardiovascular alterations in dogs infected with *Leishmania spp.*, adhering to rigorous methodological guidelines for systematic reviews.

RESULTS AND DISCUSSIONS

A total of 122 studies were initially identified across the four electronic databases. After excluding nine duplicates and 24 studies that did not meet the inclusion criteria, 89 studies proceeded to full-text review. Ultimately, 29 studies met the established criteria and were included in the systematic review.

The included studies, conducted across various continents, aimed to evaluate potential cardiac alterations induced by the *Leishmania* parasite in dogs. The review focused on using complementary diagnostic tools, such as echocardiography, electrocardiography, cardiac enzyme measurement, and blood pressure assessment, to evaluate cardiac conditions in dogs with leishmaniasis.

Veterinarians require clinical knowledge of cardiovascular alterations in animals to provide accurate diagnoses (Borges *et al.*, 2016). Cardiovascular alterations have been extensively studied in veterinary medicine to understand their association with epidemiological and etiological factors in disease diagnosis, including hypothyroidism, leishmaniasis, and ehrlichiosis (Castro, 2009). Early detection is crucial as cardiopathies can remain unnoticed, leading to severe consequences (Morais, 2008).

Dogs with leishmaniasis often exhibit cardiovascular symptoms such as cardiac arrhythmias, dyspnea, and an enlarged cardiac area (Schimming *et al.*, 2012). Additional symptoms include appetite loss, weight loss, and skin lesions, particularly on the ears and muzzle. In advanced stages, symptoms may also include onychogryphosis and paresthesia.

Studies have linked visceral leishmaniasis in dogs to elevated serum levels of cardiac enzyme markers, such as creatine kinase (CK) and cardiac troponin I. Research by Silva *et al.* (2022) revealed significantly increased enzyme activity in dogs with leishmaniasis, indicating myocardial damage.

These enzymatic alterations may reflect the inflammatory process and immune response induced by the parasite in the hearts of infected dogs.

Soares (2015), in a study of 43 seropositive dogs for leishmaniasis, observed myocardial alterations correlated with serum concentrations of total creatine kinase (CK) and the CK-MB isoenzyme. In another study involving necropsies of 29 animals, macroscopic examination revealed cardiac chamber dilation, left ventricular myocardial thickening, and right ventricular wall thinning. Microscopic examination demonstrated coagulative necrosis, myofibrillar degeneration, and myocarditis. Additionally, ten of the 43 dogs exhibited cardiac arrhythmias, and five showed alterations in heart rates.

A study conducted in Patos, Paraíba, by Mendes *et al.* (2013) reported cardiovascular abnormalities in an infected dog, including radiographic, electrocardiographic, blood pressure, and cardiac biomarker assessments. The authors highlighted the potential relationship between the direct presence of the parasite and the tissue's immune response in the development of myocardial lesions.

Sebastián-Marcos *et al.* (2019) described a case of pericardial effusion caused by Leishmaniasis in a four-year-old mixed-breed dog, leading to cardiac tamponade. Despite initial treatment, the dog did not survive. Casamián-Sorrosal *et al.* (2021) identified *Leishmania spp.* parasites in the myocardium of dogs with advanced visceral leishmaniasis.

Alves *et al.* (2010) investigated cardiac and pulmonary alterations in dogs with leishmaniasis. Histopathological, cytological, and immunohistochemical analyses revealed pulmonary changes and cardiac and pulmonary alterations in both symptomatic and asymptomatic dogs.

While most studies focus on cardiovascular examinations and histological analyses, each study contributes to understanding cardiac conditions in Leishmaniasis-infected dogs. Early intervention, appropriate treatment, and prevention of complications are crucial for improving the quality of life for affected animals.

Cardiac arrhythmias are prevalent in dogs with leishmaniasis, leading to symptoms like fatigue, reduced exercise tolerance, weight loss, and, in severe cases, collapse (Lima *et al.*, 2021b). Electrocardiography reveals various cardiac alterations, including atrioventricular block, tachycardia, atrial fibrillation, and changes in QRS complexes and RR intervals.

Echocardiography provides detailed heart structure and function visualization. Studies have shown echocardiographic abnormalities like increased heart wall thickness, dilated chambers, reduced contractility, and compromised blood flow in dogs with leishmaniasis (Silva, 2021).

Leishmaniasis can also affect blood pressure. Studies have shown increased systolic, diastolic, and mean arterial pressures in infected dogs, potentially leading to cardiovascular and renal complications (Silva *et al.,* 2020; Lima *et al.*, 2021a; Oliveira *et a*l., 2021).

Comprehensive examinations, including electrocardiography, radiography, blood pressure measurement, and cardiac biomarker assessment, are essential for detecting cardiac alterations in dogs with leishmaniasis (Mendes *et al.*, 2013).

> The etiopathogenic aspects of visceral leishmaniasis on the myocardium may be related to both the direct presence of the parasite and the tissue's immune response to the parasitic infection. However, it remains unclear whether strains of Leishmania infantum chagasi from the semi-arid region of Paraíba exhibit any tropism for cardiac tissue or induce cross-reactive immune responses, which could have clinical implications (Mendes *et al.,* 2013).

In the study by Sebastián-Marcos *et al.* (2019), a four-year-old mixed-breed dog presented with pericardial effusion causing cardiac tamponade following physical examination and echocardiography. Pericardiocentesis revealed an exudate containing *Leishmania spp.* parasites. Despite initial improvement with treatment using N-methylglucamine antimoniate and allopurinol, the dog ultimately succumbed to the condition.

Casamián-Sorrosal *et al.* (2021) conducted a study on dogs with advanced visceral leishmaniasis. Hematology, serum biochemistry, urine analysis, and culture/sensitivity tests were performed. Post-mortem examination of blood samples collected prior to euthanasia revealed the presence of *Leishmania spp.* parasites in the myocardium of the left ventricle.

Alves *et al.* (2010) employed histopathological, cytological, and immunohistochemical analyses on cardiac and pulmonary tissue samples to investigate parasitic presence and potential cardiac and pulmonary alterations. Pulmonary findings included alveolar septal thickening due to congestion, edema, inflammatory infiltrate, and fibroblast proliferation. Cytological examination also revealed cardiac and pulmonary abnormalities in both symptomatic and asymptomatic dogs. These findings suggest similarities between the observed clinical, pathological, and immunological changes and those reported in humans.

Most studies primarily focus on cardiovascular examinations and histological analyses of affected organs. These studies are crucial for evaluating and potentially developing treatment strategies for dogs infected with *Leishmania spp.* For animals deemed unsuitable for treatment or when owners decline therapy, euthanasia may be necessary. These studies provide valuable insights into cardiac conditions and their progression as determined through diagnostic testing.

Cardiac arrhythmias are prevalent in dogs with leishmaniasis, leading to symptoms such as fatigue, reduced exercise tolerance, weight loss, and, in severe cases, collapse (Lima *et al.*, 2021b). Electrocardiographic findings in infected dogs reveal a broad spectrum of cardiac alterations, including electrical conduction disturbances like atrioventricular block, and arrhythmias such as tachycardia and atrial fibrillation.

Additionally, changes in QRS complexes and RR interval duration, including prolonged QT intervals, may suggest cardiomyopathy. Electrocardiography is essential for assessing cardiac function in dogs with leishmaniasis, aiding in both diagnosis and monitoring.

Echocardiography, a non-invasive imaging technique, offers detailed visualization of the heart's structure and function. Real-time assessment of cardiac activity with high spatial resolution is possible (Oliveira, 2004). Studies have demonstrated echocardiographic abnormalities in dogs with leishmaniasis, including increased heart wall thickness, dilated chambers, reduced contractility, and compromised blood flow. These findings indicate cardiac impairment and are essential for disease management and treatment evaluation (Silva, 2021).

Beyond characteristic symptoms like weight loss, weakness, and skin lesions, leishmaniasis can also affect blood pressure in infected dogs. Research by Silva *et al*. (2020), Lima *et al*. (2021a), and Oliveira *et al*. (2021) has shown that leishmaniasis can elevate systolic, diastolic, and mean arterial pressures in affected dogs. These changes may be attributed to systemic inflammation and endothelial dysfunction caused by the parasite. Blood pressure alterations can significantly impact canine health, potentially leading to cardiovascular and renal complications.

A case of leishmaniasis in a dog presented with hypertension, with systolic, mean, and diastolic pressures recorded at 170 mmHg, 130 mmHg, and 110 mmHg, respectively (Mendes *et al.*, 2014). According to the International Renal Interest Society (IRIS, 2019), a systolic blood pressure value below 140 mmHg is considered minimal risk to target organs.

A study involving 18 dogs with leishmaniasis found systolic, mean, and diastolic pressures to be 135.2 mmHg, 105.8 mmHg, and 88.5 mmHg, respectively (Sousa *et al.*, 2016). No significant differences in blood pressure were identified between asymptomatic and symptomatic dogs.

Comprehensive examinations, including electrocardiography, radiography, blood pressure measurement, and cardiac biomarker assessment, are essential for detecting cardiac alterations in dogs with leishmaniasis (Mendes *et al.*, 2013).

CONCLUSIONS

Measurement of cardiac enzymes, electrocardiography, echocardiography, blood pressure, thoracic radiography, and parasitological and histopathological examinations are valuable tools for diagnosing and monitoring cardiac disease in dogs with leishmaniasis. Early intervention, appropriate treatment, and prevention of severe complications through these diagnostic methods can significantly improve the quality of life for affected animals.

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