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ORIGINAL ARTICLE

Non-traumatic cardiac tamponade: study in autopsy

Tamponamento cardíaco não traumático: estudo em autópsias

Marcos Adriano Garcia Campos[1], Rômullo José Costa Ataídes[2], Izabelle Smith Frazão Ramos[2], Thaís Bastos Moraes Sobrinho[3], Denner Rodrigo Diniz Duarte[4], Antonio Augusto Lima Teixeira Junior[5], Natalino Salgado Filho[4], Tiago Cordeiro Medeiros[4], Lucas Vieira de Lima[4], Pedro Manuel Barros de Sousa[4], Gyl Eanes Barros Silva[4]

ABSTRACT

Introduction: Cardiac tamponade (CT) is a cardiovascular disease with a high mortality rate. **Objective:** To determine the prevalence of non-traumatic CT and associated etiologies in an autopsy series. **Methods:** A cross-sectional study was conducted from January 2015 to March 2018, using data from 156 autopsies performed during this period at the Death Verification Service of São Luís/MA. The presence of a volume equal to or greater than 400 ml of blood in the pericardial sac defined the diagnosis of CT. **Results:** 3754 autopsies were performed during the study period, with a CT prevalence of 4.15%. The main causes of CT were aortic aneurysm rupture (48.72%) and myocardial rupture secondary to acute myocardial infarction (AMI) (51.28%). **Conclusion:** The prevalence of non-traumatic CT was 4.15%, and myocardial rupture due to AMI was the leading cause (51.28%). Additionally, there are significant differences in age and presence of comorbidities among the CT causes, highlighting the importance of clinical suspicion and early diagnosis to reduce mortality associated with cardiac tamponade.

Keywords: Cardiac tamponade; Cause of death; Autopsy; Cardiovascular diseases.

[1] Hospital das Clínicas da Faculdade de Medicina de Botucatu, Universidade do Estado de São Paulo, Botucatu, São Paulo, Brazil.

[2] Faculdade de Medicina, Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brazil.

[3] Departamento de Biologia, Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brazil.

[4] Hospital Universitário, Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brazil.

[5] Programa de Pós-graduação em Genética, Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo (USP), Ribeirão Preto, São Paulo, Brazil.

Responsible Editor:

Enio Roberto Pietra Pedroso

Faculdade de Medicina da Universidade Federal de Minas Gerais.

Belo Horizonte/MG, Brazil.

Corresponding author:

Gyl Eanes Barros Silva

Hospital Universitário da Universidade Federal do Maranhão (UFMA), São Luís, Maranhão, Brazil.

E-mail: gyleanes@alumni.usp.br

Supporting sources:

Hospital Universitário da Universidade Federal do Maranhão.

RESUMO

Introdução: O tamponamento cardíaco (TC) é uma doença cardiovascular que apresenta mortalidade elevada. **Objetivo:** Determinar a prevalência de TC não traumático e etiologias associadas em uma causuística de autópsias. **Métodos:** Estudo transversal realizado de janeiro de 2015 a março de 2018 com dados de 156 autópsias realizadas nesse período no Serviço de Verificação de Óbitos de São Luís/MA. A presença de um volume igual ou superior a 400ml de sangue no saco pericárdico definiu o diagnóstico de TC. **Resultados:** 3.754 autópsias foram realizadas no período do estudo, sendo a prevalência de TC de 4,15%. As principais causas de TC foram ruptura de aneurisma de aorta (48,72%), ruptura de miocárdio secundária a infarto agudo do miocárdio (IAM) (51,28%). **Conclusão:** A prevalência de TC não traumático foi de 4,15% como principal causa da ruptura de miocárdio devido a IAM (51,28%). Além disso, há diferenças significativas na idade e presença de comorbidades entre as causas de TC, ressaltando a importância da suspeição clínica e diagnóstico precoce para a redução da mortalidade associada ao tamponamento cardíaco.

Palavras-chave: Tamponamento cardíaco; Causa de morte; Autópsia; Doenças cardiovasculares.

Conflicts of interest:

The authors declare that they have no conflicts of interest.

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INTRODUCTION

Cardiovascular diseases are the leading causes of death worldwide[1], and cardiac tamponade (CT) is one of them. Despite its low incidence, CT presents a high mortality rate; therefore, therefore, it is a medical emergency[2] in which the diagnosis is not always made in time to begin treatment[3], swiftly leading to death.

The main causes of CT due to hemopericardium are trauma, myocardial rupture secondary to acute myocardial infarction (AMI), aortic aneurysm rupture, cardiac surgery, cardiac perforation secondary to invasive procedures, anticoagulants, and neoplasms[4].

CT occurs when there is an increase in intrapericardial pressure relative to intracardiac pressure. While a delayed or chronic collection of fluid in the pericardium can allow an increase of 1000 to 2000 ml before becoming significantly impactful, a rapid accumulation of just 250 ml can inhibit cardiac output and is considered acute CT[5].

Post-mortem CT is primarily related to hemopericardium, which occurs due to myocardial rupture from AMI or aortic aneurysm rupture[6].

It is essential to identify the clinical differences between myocardial rupture secondary to acute myocardial infarction and aortic aneurysm rupture through the anatomopathological study of autopsied patients to determine the cause of death. Currently, autopsy studies are underutilized by academics and professionals, rarely advocated by clinicians and even pathologists, and are frequently neglected as a resource for medical investigation. However, autopsy studies offer numerous benefits and advantages for both medical practice and society.

Autopsies make it easier to evaluate of new medications on the market and their potential adverse effects on the body. Additionally, autopsies may provide information on atypical manifestations of some diseases that would be difficult to detect and analyze in living patients[7]. They provide essential data to determine the primary cause of death and may elucidate associated pathologies and disease progression. In this context, death verification services contribute to clarifying poorly defined natural causes of death, enabling better planning and implementation of health policies[8].

A comprehensive literature review reveals critical clinical, epidemiological, and anatomopathological aspects of cardiac tamponade. Clinically, cardiac tamponade manifests signs such as decreased cardiac output, jugular vein distention, muffled heart sounds, and arterial hypotension, requiring rapid intervention due to the risk of systemic hypoperfusion[9]. Epidemiologically, the incidence of cardiac tamponade is diverse; the most common etiologies are neoplasms, infections, and idiopathic causes. In a study conducted in an Asian center, malignancy was identified as the primary cause, with a prevalence of 60.9%, while other etiologies included infections, uremic effusions, and rheumatologic diseases[10]. Anatomopathologically, the analysis of pericardial effusions in patients with and without tamponade showed significant etiological differences, with post-surgical and post-procedure effusions presenting more commonly in tamponade cases, while idiopathic etiologies predominated in the absence of tamponade[9]. Such studies underline the importance of autopsies for the precise determination of causes of death and effective health policy planning.

Therefore, this study aimed to determine the prevalence of non-traumatic CT and associated etiologies in an autopsy series. Thus, it was necessary to estimate the prevalence of cardiac tamponade in autopsies, define etiologies of cardiac tamponade, and analyze clinical and anatomopathological characteristics of cardiac tamponade cases and their relation to etiology.

Methods

A cross-sectional study was conducted from January 2015 to March 2018 using data on deaths recorded at the Death Verification Service (SVO) of São Luís/MA. The SVO of São Luís is a state public body that performs autopsies on patients who died without a history of violent death. The profile includes deaths that occurred at home, in public places, and in hospitals when the cause of death was not yet diagnosed.

The data used were retrospective (January 2015 to March 2018), from the Death Certificate (DO) and autopsy reports available at the SVO, filled out by a pathologist. During this period, 3754 autopsies were performed.

All cases where the immediate cause of death found in the autopsy was due to CT from hemopericardium, without being justified by another disease or condition, were included. Two cases related to cardiac malformation and two cases of pericarditis were not included. Also, cases of aortic dissection were not included, since they were associated with hemothorax. Thus, 156 cases of CT were included.

The researchers had access to the SVO database and reports. Variables collected included age, sex, place of death, comorbidities, previous clinical symptoms, cause of death, performance of cardiopulmonary resuscitation (CPR), heart weight, and other autopsy findings.

Age, sex, and place of death information were taken from the DO. The presence of comorbidities such as systemic arterial hypertension (SAH), diabetes mellitus (DM), alcoholism, smoking, and chronic renal failure (CRF) was reported by family members and recorded in the SVO reports.

The autopsy was performed by a pathologist and two technicians, at least six hours after death. The body was opened by a single incision from the sternal manubrium to the pubic bone. To access thoracic structures, the ribs were cut at the midclavicular line with pliers, and the sternum with the anterior part of the rib cage was removed.

The heart and lungs were first analyzed in situ. The presence of blood in the pericardial sac was noted during inspection. Then, the pericardial sac was cut longitudinally with scissors, to check for blood. Adjacent structures, such as the thoracic aorta, were also examined. The heart was then removed at the aorta base and analyzed separately by the pathologist.

SVO reports noted the volume of blood removed from the pericardial sac. The presence of a volume equal to or greater than 400ml of blood in the pericardial sac[11] defined the diagnosis, measured in a standardized service container with 10 ml accuracy. This volume represents an abnormal amount of fluid in the pericardial sac, which normally contains 20 to 60ml[11].

The cause of CT from aortic aneurysm rupture was defined by observing aneurysmal dilation and structural discontinuity; CT from myocardial laceration secondary to myocardial rupture from AMI was considered when there was loss of continuity of the heart chamber walls associated with recent transmural AMI (brownish or yellowish color of the myocardium and friable texture), or from pericarditis, with reddish coloring and edema in the pericardial sac.

Ischemic heart disease was diagnosed from grayish fibrotic lesions seen in transverse cuts of the myocardium. Increased volumetric capacity of the heart chambers and decreased wall thickness was characterized as cardiac dilation, and increased myocardial wall thickness and decreased chamber lumen was defined as cardiac hypertrophy. Pneumonia was considered when there was consolidation with purulent secretion from the lung parenchyma.

Atherosclerosis was defined when atherosclerotic plaques were found in coronary arteries, the aorta, and other body vessels. Renal atrophy was characterized by decreased renal volume and loss of corticomedullary differentiation. Pulmonary, hepatic, splenic, and renal congestion were defined when there was fluid accumulation in the parenchyma of these organs, with increased volume and weight; more markedly in the lungs there was fluid release upon mechanical compression of the parenchyma.

Information on previous clinical signs and attempts at CPR was taken from medical reports from emergency services and hospitals of origin for those patients who died in hospitals, and attached to SVO reports.

Autopsy findings were recorded during the examination and documented in SVO reports. The heart was weighed on an electronic scale with 10g accuracy after being removed from the chest cavity, separated from the pericardial sac, and drained of coagulated blood from the chambers.

The clinical symptom of precordial pain was defined when hospital reports mentioned "chest pain" or "anginal pain". Back pain was noted when "back pain" or "pain radiating to the posterior region" was mentioned. Abdominal pain was noted when there was "epigastric pain" or "diffuse abdominal pain". Sudden loss of consciousness was considered in cases with reports of "fainting" or "sudden change in consciousness level".

Stata 14.0 was used for statistical analyses. Categorical variables (sex, place of death, comorbidities, previous clinical symptoms, performance of CPR, autopsy findings) were presented as simple frequencies and percentages. Continuous variables (age, and heart weight) were presented as mean and standard deviation. Age was categorized into "<50 years", "50 to 70 years", and ">70 years" groups. To estimate differences between categorical variable groups and the cause of CT (aneurysm rupture or transmural AMI), the adjusted Chi-square was used and calculated with a 95% confidence interval.

The project was approved by the ethics committee of the University Hospital of the Federal University of Maranhão (protocol number: 4.069.664).

Results

During the study period, 3754 autopsies were recorded, with 156 cases of CT. Therefore, the prevalence of CT was 4.15% (±0.003). The identified causes of CT were aortic aneurysm rupture in 76 patients (48.72%) and myocardial rupture secondary to acute myocardial infarction (AMI) in 80 patients (51.28%). Thus, the two main etiologies (aneurysm and AMI) were considered for analysis.

Table 1 describes the characteristics of the sample studied and compares differences between groups regarding etiology. The mean age was 68.11 years (±1.14), and individuals over 70 years were 48.45%. AMI as a cause of CT was more common in >70 years, while the aneurysmal cause was more frequent in <50 years (p=0.012). The mean age of patients who suffered AMI and aneurysm rupture was 71.82 years (±1.47) and 64.97 years (±1.71), respectively. Regarding gender, the female was more frequent (53.42%). The main place of death was the hospital (51.55%). Patients with DM had more CT secondary to AMI (p=0.041). The finding of atherosclerosis was more common in AMI cases (p=0.026).

Precordial pain (p=0.013) and abdominal pain (p=0.021), as well as the performance of CPR, were more common in patients with CT due to AMI. Other reported symptoms were cough (1.86%), vomiting (3.11%), diaphoresis (3.11%), and headache (2.48%). Table 2 indicates the anatomical location of lesions from AMI and aortic aneurysm.

Table 1. Clinical and sociodemographic characteristics of patients with cardiac tamponade as the cause of death submitted to autopsies in São Luís, 2015 to 2018.

		Cardiac Tamponade Etiology		
Variables	**%**	**Aneurysm n (%)**	**AMI n (%)**	***p*-Value***
Age				
<50 years	9.94	12 (85.71)	2 (14.29)	
50 to 70 years	41.61	31 (47.69)	34 (52.31)	0.012
>70 years	48.45	33 (42.86)	44 (57.14)	
Gender				
Male	46.58	38 (52.78)	34 (47.22)	0.348
Female	53.42	38 (45.24)	46 (54.76)	
Place of Death				
Hospital	51.55	40 (50)	40 (50)	
Home	41.61	30 (46.15)	35 (53.85)	0.82
Public places	6.83	6 (54.55)	5 (45.45)	
Comorbidities				
SAH	64.60	50 (50.51)	49 (49.49)	0.556
DM	19.88	10 (32.26)	21 (67.74)	0.041
CRF	7.50	7 (63.64)	4 (36.36)	0.294
Smoking	13.04	8 (38.10)	13 (61.90)	0.295
Alcoholism	4.97	2 (25)	6 (75)	0.168
Ischemic heart disease	8.70	8 (57.14)	6 (42.86)	0.509
Previous Stroke	4.97	3 (37.50)	5 (62.50)	0.515
Autopsy Findings				
Atherosclerosis	54.04	35 (40.70)	51 (59.30)	0.026
Cardiac Dilation	7.45	8 (66.67)	4 (33.33)	0.195
Cardiac Hypertrophy	37.27	30 (50.85)	29 (49.15)	0.678
Pulmonary Congestion	36.65	23 (39.66)	35 (60.34)	0.081
Hepatic/Splenic Congestion	44.72	32 (45.07)	39 (54.93)	0.405
Renal Congestion	24.22	17 (43.59)	22 (56.41)	0.459
Gastritis	11.18	9 (50)	9 (50)	0.908
Renal atrophy	12.42	9 (45)	11 (55)	0.722

continue...

... continued Table 1

		Cardiac Tamponade Etiology		
Variables	**%**	**Aneurysm n (%)**	**AMI n (%)**	***p*-Value***
Clinical Symptoms				
Precordial Pain	22.98	11 (30.56)	25 (69.44)	0.013
Abdominal Pain	7.45	2 (16.67)	10 (83.33)	0.021
Back Pain	5.59	3 (33.33)	6 (66.67)	0.341
Sudden Loss of Consciousness	12.42	6 (30)	14 (70)	0.073
Dyspnea	16.15	11 (42.31)	15 (57.69)	0.474
Performing CPR	27.33	14 (32.56)	29 (67.44)	0.013

Legend: n = Absolute value; % = Percentage; AMI = Acute myocardial infarction; SAH = Systemic arterial hypertension; DM = Diabetes *mellitus*; CRF = Chronic renal failure; CPR = Cardiopulmonary resuscitation. *Adjusted Chi-square used.

Table 2. Description of the location of myocardial rupture due to acute myocardial infarction and rupture of aortic aneurysm that caused cardiac tamponade. São Luís, 2015-2018.

Location of AMI lesion (n = 58)	**n (%)**
Left Ventricular Anterior Wall	38 (65.51)
Left Heart Base	2 (3.44)
Atrium	2 (3.44)
Left Ventricle Apex	4 (6.89)
Right Ventricle	3 (5.17)
Left Ventricle Posterior Wall	8 (13.79)
Left Ventricle Inferior Wall	1 (1.72)
Aneurysm lesion location (n = 68)	**n (%)**
Descending Aorta	22 (32.35)
Aortic arch	8 (11.76)
Ascending Aorta	12 (17.64)
Aortic Base	12 (17.64)
Inferior Vena Cava	14 (20.58)

Legend: n = Absolute value; % = Percentage; AMI = Acute myocardial infarction.

Discussion

The differences between cardiac tamponade (CT) due to myocardial rupture caused by acute myocardial infarction (AMI) and CT due to aortic aneurysm rupture are related to age: adults have a higher incidence of aneurysms and those over 70 years have a higher incidence of AMI. Additionally, regarding the presence of a history of diabetes mellitus (DM) and atherosclerosis, the latter is more common in AMI. Regarding clinical symptoms, precordial pain and abdominal pain were more frequent in patients with CT due to AMI.

In our study, the prevalence of CT found was 4.15%, similar to the prevalence of 4.74% evidenced in another study with 2056 autopsies[13], demonstrating that it is a frequent cause of sudden death[12]. The age group of aneurysm rupture victims was younger compared to AMI, indicating that clinical suspicion may be influenced by the patient's age. A retrospective analysis considering 1323 deaths over a 10-year period found that 128 cases could be classified as sudden cardiac deaths, of which 10.9% were caused by cardiac tamponade[14].

Tuberculosis and bacterial infections are traditional causes of CT, except when related to pericardial effusion caused by cancer. Other common etiologies of CT include lung and breast cancer[15]. In general, the most common causes of acute CT are pericarditis, thoracic aorta rupture, ventricular wall rupture associated with AMI (especially if there is ST-segment elevation), and invasive cardiovascular procedures, including central access placement[16]. This explains why, in acute cases, the main causes of CT are related to thoracic aorta rupture and myocardial rupture, as observed in this study.

The high frequency of AMI and atherosclerosis cases confirms the literature findings, pointing to ischemic heart disease as the main cause of cardiovascular death in almost the entire country. In individuals over 45 years old, coronary artery disease is more common and is associated with sudden cardiac death[17,18]. However, the diagnosis of AMI in autopsies can be hindered, since histological changes tend to occur only 12 hours after the episode, so it is difficult for the pathologist to confirm the diagnosis. In our series, all cases of CT secondary to AMI had typical histopathological findings of cardiac ischemia.

Cardiac rupture remains one of the main causes of in-hospital death in patients with AMI, especially in elderly patients with larger infarcts and more intense inflammation[19]. Although reperfusion therapies have become more common worldwide, cardiac rupture is a significant complication causing death in hospitalized patients with AMI[20]. This catastrophic cardiovascular emergency is characterized by a high mortality rate, ranging from 75% to 89%[21]. This is confirmed by the high percentage of cardiac rupture identified in autopsies of patients who died from AMI. Some studies have reported that 24% of post-AMI deaths were due to cardiac rupture[22]; one study found that 12.3% of unexpected sudden deaths were caused by cardiac rupture confirmed by autopsy[23], and another demonstrated that myocardial rupture was responsible for 46.8% of non-traumatic cardiac tamponades out of a total of 79 cases confirmed by autopsy[24].

The high percentage of cardiovascular deaths confirmed by autopsy indicates that cardiac rupture and complications such as CT may have been globally underestimated due to diagnostic errors, such as other causes of sudden death post-AMI[25].

The predominance of DM among the comorbidities presented by patients with AMI may reflect the increasing rise of obesity and dyslipidemia, which are triggering factors for DM in the Brazilian population[26]. On the other hand, systemic arterial hypertension (SAH) was present in both the AMI patient group and the aortic aneurysm rupture group, not being a differentiating factor between the two groups.

AMI has some characteristics that can differentiate it from non-cardiac chest pain. In general, AMI presents symptoms with severe precordial pain that worsens with physical exertion and radiates to the upper extremities. Additionally, the pain is associated with diaphoresis, nausea, vomiting, or dyspnea[27]. In contrast, an aortic aneurysm can present in several ways, possibly being asymptomatic when there is no rupture[28]. In rupture cases, the classic finding of pain radiating to the back[29] was not observed in the present study.

Ascending thoracic aortic aneurysm has an estimated incidence of 5.6 to 10.4 cases per 100,000 patient-years[30]. Several conditions can cause aortic aneurysms, including trauma, age-related degeneration, atherosclerosis, chronic aortic dissection, aortitis, and genetically determined syndromes such as bicuspid aortic valve, Marfan syndrome, Loeys-Dietz syndrome, Ehlers-Danlos syndrome, and Turner syndrome[31].

Aortic rupture and aortic dissection are the two most dangerous complications[32]. Less than 50% of patients with ruptured aortic aneurysm survive to reach the hospital, and the mortality rate is approximately 97% to 100% of cases[29]. This fatal complication occurs because free rupture results in massive bleeding hindered by periaortic structures, such as the pleura, pericardium, and adjacent organs, causing hemodynamic instability[33].

A limitation of the study was the access to clinical data based on family reports and records from SVOs. SVO records were obtained from medical records when the case was referred from a hospital to the service, ensuring that the report of signs and symptoms was reliable.

The findings of this study hold significant clinical implications. Healthcare professionals should be vigilant for the possibility of cardiac tamponade (CT) in patients presenting with compatible symptoms, particularly those with risk factors such as diabetes mellitus (DM) and atherosclerosis. Future research could focus on specific interventions to reduce mortality associated with CT, as well as methods to improve the accuracy of post-mortem diagnoses. Additionally, further studies could explore the impact of different CT management strategies on mortality and morbidity.

In conclusion, our study identified a significant prevalence of non-traumatic CT in an autopsy sample, with myocardial infarction (MI) and aortic aneurysm rupture being the primary causes. The identification of significant differences in age and comorbidities between these etiologies underscores the importance of early diagnosis and appropriate interventions to reduce mortality associated with CT.

Author's Contributions

We describe contributions to the papers using the taxonomy (CRediT) provided above: *Conceptualization, Investigation, Methodology, Visualization & Writing – review & editing*: MAGC; GESB; RJCA; TBMS; TCM; NSF. *Project administration, Supervision & Writing – original draft*: MAGC; GESB; LVL; PMBS; DRDD; AALTJ. *Validation & Software*: MAGC; GESB. *Resources & Funding acquisition*: GESB; NSF. *Data curation & Formal Analysis*: GESB; MAGC; AALTJ.

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