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REVIEW ARTICLE

Atrial Fibrillation in the Perioperative Period of Liver Transplantation: An Integrative Review

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ABSTRACT

Objective: To review the development of atrial fibrillation (AF) during the perioperative period (intraoperative and postoperative) in liver transplant recipients. **Methods:** This integrative review sought to analyze the emergence of AF in the perioperative period of liver transplantation and its associated factors. The following databases were used: PubMed, MEDLINE, SciELO, and Scopus. The descriptors were interchanged using the boolean operator "AND", with a time restriction of 10 years, in English and Portuguese. Initially, 305 articles were found, of which nine met the proposed objective after analysis. **Results:** In this review, nine articles were selected, categorized according to the onset of AF concerning liver transplant surgery: three concerning the onset of AF in the intraoperative period and six in the postoperative period. During the intraoperative period, cases of AF had a higher incidence after reperfusion of the liver graft. In addition, the group with AF had a higher incidence of liver failure, a higher model for end-stage liver disease (MELD) scores, higher serum total bilirubin concentrations, and increased international normalized ratio (INR) values. AF in the postoperative period was associated with older patients, higher MELD scores, and renal dysfunction. Hospital stay was prolonged, and the risk of mortality was increased in patients with postoperative AF. **Conclusion:** The appearance of AF in the perioperative period of liver transplantation suggests a correlation with patients with higher MELD scores, advanced age, and instability during surgery and may indicate a poor prognosis for the patient.

Descriptors: Atrial Fibrillation; Liver Transplantation; Intraoperative Period; Postoperative Period.

Fibrilação Atrial no Perioperatório de Transplante de Fígado: Uma Revisão Integrativa

RESUMO

Objetivo: Revisar o desenvolvimento da fibrilação atrial (FA) durante o período perioperatório (intra e pós-operatório) em receptores de transplante de fígado (TxF). **Métodos**: Trata-se de uma revisão integrativa que buscou analisar o surgimento da FA no perioperatório de transplante hepático, bem como seus fatores associados. Utilizaram-se as bases de dados PubMed, MEDLINE, SciELO e Scopus. Os descritores foram permutados utilizando o operador booleano "AND", com a restrição temporal de 10 anos, nos idiomas inglês e português. Inicialmente, foram encontrados 305 artigos, dos quais nove atenderam ao objetivo proposto após a análise. **Resultados**: Nesta revisão, foram selecionados nove artigos, os quais foram categorizados de acordo com o momento de surgimento da FA, em relação à cirurgia de transplante hepático: três em relação ao surgimento da FA no intraoperatório (FAIO) e seis no pós-operatório. Durante o período intraoperatório, os casos de FA apresentaram maior incidência após a reperfusão do enxerto hepático. Além disso, o grupo com FA apresentou maior incidência de insuficiência hepática, pontuações mais altas no escore *model for end-stage liver disease* (MELD), concentrações séricas mais elevadas de bilirrubina total e valores aumentados de *international normalized ratio* (INR). A presença de FA no pós-operatório (FAPO) foi associada a pacientes de idade avançada, com escores MELD mais elevados e disfunção renal. A permanência hospitalar foi prolongada e o risco de mortalidade foi aumentado em pacientes com FAPO. **Conclusão**: O aparecimento da FA no perioperatório de transplante de fígado sugere uma correlação com pacientes de escores MELD mais altos, idade avançada e possibilidade de ocorrerem instabilidades hemodinâmicas, como arritmias durante a cirurgia, podendo indicar um mau prognóstico para o paciente.

Descritores: Fibrilação Atrial; Transplante de Fígado; Período Intraoperatório; Período Pós-Operatório.

INTRODUCTION

Liver transplantation (LTx) is the surgical treatment for patients with end-stage liver disease, as a complex procedure with a possible or greater probability of occurrence of critical cardiovascular events. The surgical procedure is indicated for adult and pediatric patients who have acute or chronic, irreversible and progressive liver diseases, with transplantation being the only alternative to improving quality of life. The average age range of LTx recipients is 50 years old. Around 70% of patients who received LTx in the United States of America (USA) in 2011 were 50 years old, and almost 12% were 65 years old[1].

Age alone can play a significant role in assessing the risk associated with surgical procedures, as aging is often associated with physiological changes and chronic medical conditions[1]. Thus, age becomes a risk factor for perioperative complications, one of which is the development of atrial fibrillation (AF)[2]. According to the studies by Wilke et al.[3], which analyzed the prevalence of AF in 8.3 million patients in Germany, it was reported that the average age of patients with AF was 73.1 years, and 55.5% were male. In all age groups, the incidence of AF is more common in men than in women[3].

AF represents a cardiac arrhythmia characterized by uncoordinated and irregular contractions of the heart's upper chambers. This phenomenon assumes significant clinical relevance when it manifests in the perioperative context of LTx, a complex surgical procedure. In the US, at least 3 to 6 million individuals are affected by AF, with projections indicating that this number could reach approximately 6 to 16 million by 2050. In Europe, the number of individuals with AF is expected to reach 14 million by 2060, among people over 55 years old[4].

The relationship between AF and LTx not only influences the patient's cardiovascular outcome but directly impacts the morbidity and mortality associated with this intervention. It is worth noting that arrhythmia is clinically meaningful because it can be associated with significant hemodynamic instabilities, specifically in patients undergoing LTx. Patients undergoing LTx are often exposed to factors predisposing to AF, such as surgical stress, elevated levels of catecholamines, and intravenous fluids that add preload and increase afterload, placing significant stress on the cardiovascular system[5].

AF in LTx is a significant clinical concern as it may adversely impact patients' prognosis. Studies highlight that AF is associated with cardiovascular complications and increases the risk of thromboembolic events, such as cerebrovascular accident (CVA) and heart failure, as well as increased mortality in the general population. However, individuals who experience AF during the perioperative course constitute a poorly studied subgroup in this population. Furthermore, the effects of AF in patients undergoing LTx are still largely unknown[6].

Given this, this study's relevance lies in identifying the factors associated with the emergence of AF during the perioperative period in LTx recipients. This analysis of the available scientific literature contributes to understanding the mechanisms underlying AF in this complex context and can guide clinical strategies for preventing and managing this critical complication.

METHODS

The present study consists of an integrative review that used the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocol to analyze the presence of AF in adults during the LTx perioperative period. The review's guiding question elaboration was based on the PICO strategy, an acronym for P: population/patient, I: intervention, C: comparison/control and O: outcome. Therefore, the following question was created: what evidence is present in the literature on the development of AF during the perioperative period of LTx recipients?

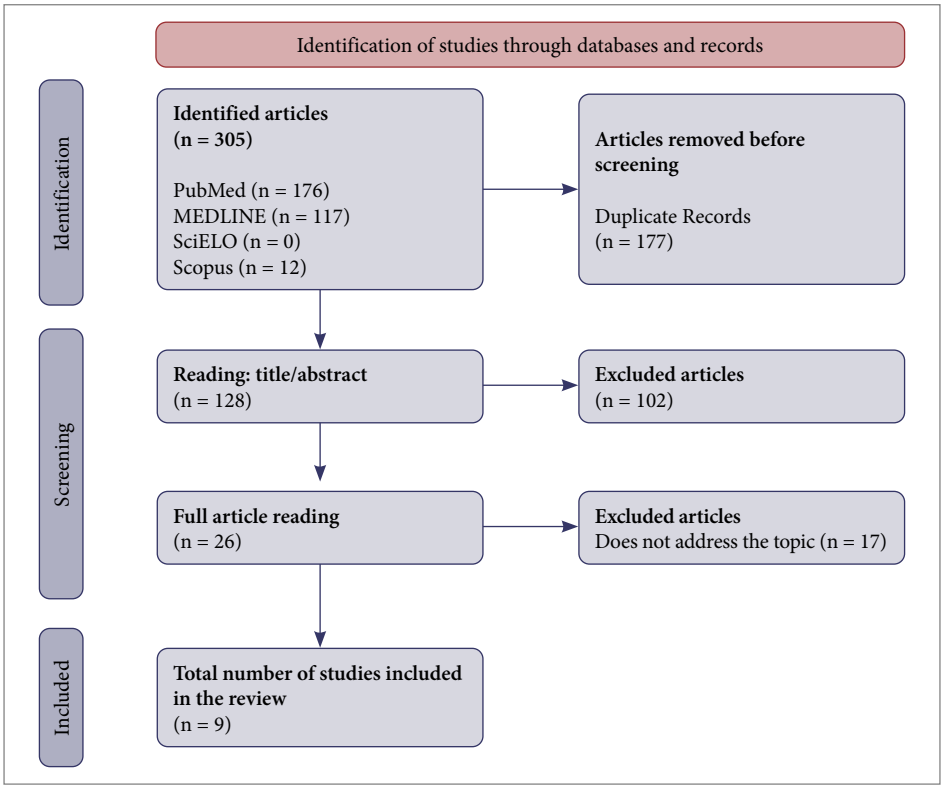
The literature search was carried out in the databases PubMed [service of the US National Library of Medicine (NLM)], MEDLINE, Scientific Electronic Library Online (SciELO) and Scopus. The search terms were validated by the Health Sciences Descriptors (DeCS) "Atrial Fibrillation", "Liver Transplantation", "Intraoperative Period", "Postoperative Period" and "Arrhythmias Cardiac". The descriptors were permuted using the Boolean operator "AND" and a temporal restriction of 10 years was applied. Data was collected by targeting articles that addressed analyses of the intraoperative and postoperative period of LTx, in which the emergence of recent-onset AF occurred.

As inclusion criteria for sample selection, original articles available in full were included, published between 2013 and 2023, in English and Portuguese, on individuals over 18 years of age. Additionally, case reports were included in the research. The exclusion criteria used were published works that deviated from the central objective of the review, articles aimed at the pediatric population, research without a scientific nature and inadequate studies, such as letters to the reader and newspaper editorials.

Initially, the articles were selected by reading the title and abstract. Then, the pre-selected articles were read in full. Finally, the studies that answered the guiding question were attached to the integrative review sample. Duplicate articles in more than

one database were considered only once. In this context, the emphasis of the search was directed to scientific articles that dealt with the emergence of AF in the perioperative period, also considering its potential complications. In this study, we only included articles that addressed patients with new-onset AF, defined as occurring during the operative period and up to 30 days after LTx, as long as they did not have chronic (persistent) AF at the time of LTx surgery[5].

In data collection, the following information was sought: author's name, year of publication, country of publication, study objective, sample size, moment of transplantation at which AF occurred (intra, postoperative), design of the study and main results. The collected material was analyzed and summarized in the attached tables. Zotero software was used to exclude duplicate articles and organize them. The research strategy outlined in the PRISMA Statement 2020 was also followed[7], according to the EQUATOR Network CARE Guidelines for systematic reviews, described in Fig. 1.



Source: Elaborated by the authors.

Figure 1. Screening of articles with the systematic review flowchart (PRISMA).

RESULTS

Initially, 305 articles were identified, and nine were selected. The first selection stage was restricted to the descriptors used in the research, and 305 articles were identified. Then, the inclusion and exclusion criteria were applied, leaving 128 articles analyzed by title and abstract. For full-text analysis, 26 articles were selected. After complete reading, nine articles were chosen and divided according to the onset of AF concerning liver transplant surgery: three concerning the onset of intraoperative AF (IOAF) and six in the postoperative period.

Intraoperative

Three articles reported the emergence of IOAF from LTx: two case reports and one retrospective study (Table 1). Prakash et al.[8] mention the development of AF and supraventricular tachycardia (SVT) during the anhepatic phase of living donor LTx. Male patient, 40 years old, with chronic alcoholic liver disease, without preexisting cardiac comorbidities and with a normal preoperative echocardiogram. During dissection, 13 units of packed red blood cells, 10 units of fresh plasma, one platelet concentrate and six cryoprecipitates were administered. Other disorders, such as hypocalcemia, tachycardia, oliguria and metabolic acidosis, were observed and corrected intraoperatively. The anhepatic phase lasted 3.5 hours. During this period, the patient remained hemodynamically unstable, with the use of norepinephrine and vasopressin throughout the surgery. After 3 hours of anhepatic phase, there was a sudden onset of SVT that responded to 6 mg of intravenous adenosine. Five minutes later, there was a recurrence of SVT that did not respond to doses of adenosine. Then, the rhythm changed to AF with a ventricular rate of around 110/min.

Acidosis, hypo/hyperkalemia, hypocalcemia, hypoglycemia, and hypothermia were ruled out. During reperfusion, the rhythm remained irregular, with continuous AF. After surgery, the patient was monitored in the intensive care unit, and the rhythm was reverted to sinus 10 hours after surgery[8].

Table 1. Summary of liver transplant IOAF studies.

Reference/ country	Year of publication	Type of Study	Study objective	Sample size	Incidence of AF	Main results
Prakash et al.[8] India	2019	Case report	Report the occurrence of SVT and AF during the anhepatic phase of living donor LTx and describe its management.	1	-	New-onset SVT or AF may occur in the anhepatic phase of LTx. Factors attributed to the development of AF during LTx include alcoholism, hypomagnesemia, preexisting cardiac conditions, massive blood loss, and acid-base and electrolyte imbalances. Although AF may be present preoperatively, it has also been described after reperfusion.
Li et al.[9] China	2022	Case report	To describe the case of a patient who presented with new-onset AF during orthotopic liver transplantation that may have been induced by injection of ice-cold saline to measure TPTD.	1	-	AF occurs during the dissection of the recipient's liver. The incidence of AF was due to the infusion of cold saline solution to measure TPTD during orthotopic liver transplantation. The onset of AF during LTx can be self-limited, often lasting between 1 hour and 1 week.
Moon et al.[10] South Korea	2018	Retrospective cohort study	To describe the occurrence of newly developed IOAF during LTx and evaluate patient outcomes concerning the duration of AF.	1,059	1.20%	Higher MELD scores and fulminant liver failure may contribute to developing IOAF.

Source: Elaborated by authors

In another study, Li et al.[9] report a 52-year-old male patient who underwent LTx due to alcoholic cirrhosis associated with portal hypertension. AF occurred with a ventricular rate of 120 bpm, 3 minutes after the injection of cold saline solution during transpulmonary thermodilution (TPTD). In the reperfusion stage, hemodynamic instability was controlled with norepinephrine. The neo-hepatic phase was uneventful. AF persisted for 5 days and automatically reverted to sinus rhythm[9].

Besides that, Moon et al.[10] demonstrated, in their retrospective cohort study, 13 cases of AF diagnosed during the intraoperative period, representing 1.2% of the total. Of these cases, the highest incidence occurred immediately after reperfusion of the liver graft (n = 8), while the others were observed in the pre-anhepatic (n = 2) and anhepatic (n = 3) phases. The duration of IOAF was generally brief, with seven patients lasting < 1 hour and four patients reverting AF to sinus rhythm before hospital discharge. In this study, two patients died on the 6th and 52nd postoperative days. Among the preoperative factors related to the receptor, the group with AF had a higher incidence of fulminant liver failure, higher values in the model for end-stage liver disease (MELD) score, in the serum concentration of total bilirubin and the international normalized ratio (INR) (Table 2). The studies' analysis noted a higher mortality prevalence among individuals who developed IOAF[10].

Table 2. Patient data according to the development of AF.

Moon et al.[10]	Age	MELD	INR	Serum bilirubin
Patients with IOAF	45.4	31.5	2.8	34.7
Patients without IOAF	50.6	18.8	1.7	2.8

Source: Elaborated by authors

Postoperative

When reviewing the literature, the relevance of postoperative AF (POAF) was highlighted, and six articles were identified that investigated its occurrence shortly after LTx (Table 3). These surveys included five retrospective studies[5,6,11-13] and a meta-analysis[14]. Among the studies in this scenario, five articles related the presence of POAF in significantly older patients with a high MELD score and renal dysfunction.[5,6,12-14].

Table 3. Summary of POAF studies of liver transplantation.

Reference/ country	Year of publication	Type of Study	Study objective	Sample size	Incidence of AF	Main results
Xia et al.[5] USA	2015	Retrospective cohort study	To investigate the incidence, impact and risk factors of POAF in patients with LTx.	1,387	7.4%	Patients with POAF were significantly older, with higher MELD scores and baseline creatinine levels. A history of AF before LTx and the need for a pre-transplant vasopressor was significantly associated with the development of POAF after LTx. Hospital stays were significantly more extended in patients who developed POAF. The incidence of acute kidney injury in the POAF group was 24.3%, considerably higher than that in the non-POAF group (11.8%).
Nicolau-Raducu et al.[11] USA	2015	Retrospective cohort study	To investigate the role of reported predictor variables on the incidence of early and late cardiac morbidity and mortality in a high-risk group of liver transplant recipients.	389	2.6%	During the initial year after LTx, cardiovascular morbidity and mortality rates of 15.2 and 2.8%, respectively, were observed. Among patients crossing the 1st year, morbidity and mortality rates were 3.9 and 2%, with cardiovascular etiology being the third cause of death.
Koshy et al.[6] Australia	2021	Retrospective cohort study	To evaluate whether POAF was associated with the risk of stroke and systemic embolism in an unselected population of patients undergoing LTx	461	10.2%	POAF after LTx is common and is associated with an eightfold increased risk of thromboembolic events, and the use of the CHA_2DS_2-VASc score may facilitate adequate risk stratification of these patients.
Molinari, Michele et al.[14] USA	2019	Meta-analysis	To evaluate whether the presence of AF in kidney and liver transplant recipients was associated with inferior patient and graft survival.	2,239	6.8%	In the presence of AF, the risk of mortality increased by 2.3 for LTx recipients. The risk of graft loss showed no statistically significant difference after LTx, probably due to the small number of patients with LTx and AF.
Rivas et al.[12] USA	2022	Retrospective cohort study	To identify predictors of new-onset POAF during the first 90 days after LTx and evaluate the association between POAF and in-hospital and 1-year mortality.	857	10.4%	Patients who had new-onset AF were older, more likely to be white, have a higher MELD score, and more likely to have a history of renal dysfunction requiring dialysis, coronary artery disease, hypertension, chronic obstructive pulmonary disease, ascites, hepatorenal syndrome and pulmonary hypertension.
Rachwan et al.[13] USA	2020	Retrospective cohort study	Determine the incidence of POAF, identify associated risk factors and evaluate outcomes in FTx.	1,011	10%	The incidence of POAF was significantly higher in patients with non-alcoholic fatty liver disease. A higher MELD score and age over 50 were also factors associated with an increased incidence of POAF.

Source: Elaborated by authors

The CHA_2DS_2-VASc score is an index that stratifies the risk of stroke in patients with AF, and the MELD score estimates the relative severity of liver disease.

Xia et al.[5] reported that AF in LTx recipients manifested itself in the 1st month post-surgery. Furthermore, all patients with POAF converted to sinus rhythm after treatment, and no persistent or chronic AF was documented at discharge. The hot and cold ischemia intervals were similar throughout the intraoperative course, revealing no disparities between the two groups. In the POAF group, there was a decrease in urinary output and a greater demand for fresh plasma and packed red blood cells compared to the group without POAF. Hospital stay was significantly more extended in patients who developed POAF[5].

In the study conducted by Koshy et al.[6], the cold ischemia and warm ischemia times were also equivalent. The onset of POAF occurred on average 3 days after transplantation. It was found that only five (10.6%) patients with POAF maintained persistent AF at discharge after LTx. The total length of stay stratified by POAF was not significantly different between the groups. In contrast, the incidence of AF 12 months after LTx was considerably higher in patients who developed POAF[6].

Rivas et al.[12] realized, in their data analysis, that patients with a history of dialysis, hepatorenal syndrome and pulmonary hypertension had a higher prevalence in the development of POAF. Intraoperatively, patients who developed POAF had more significant blood loss and received more colloids and blood products. In contrast to the analysis by Koshy et al.[12], the length of hospital stay observed was longer in the presence of POAF compared to the group without POAF. Furthermore, when assessing mortality, patients who developed AF had a 2.64 times higher risk of death within one year[12].

Besides that, Rachwan et al.[13] reported the presence of POAF in 102 (10%) patients, of which eight had a preexisting history of AF or atrial flutter (AFL). The group of patients with POAF had a higher incidence of non-alcoholic fatty liver disease compared to those without POAF. Patients with POAF had more extended hospital stays and a higher frequency of post-transplant hospitalizations. Patients with POAF had a higher graft failure rate at one year than those without POAF. The median time after LTx to the first episode of AF was three days, with 72% of cases resolved within 48 hours of onset. The most commonly used vasopressors during POAF initiation were norepinephrine and vasopressin. It was observed that 13% of patients with POAF died during intensive care unit (ICU) admission for LTx, and two had unresolved documented AF. Medications frequently used to treat POAF included amiodarone, beta blockers and calcium channel blockers[13].

DISCUSSION

Intraoperative Atrial Fibrilation (IOAF)

A large cohort study reported the presence of IOAF during LTx in patients without a previous history of AF, correlating it with the risk of postoperative mortality. In the study of Xia et al.[5], 5 AF cases (0.4%) were found on the day of LTx. However, it is essential to highlight that the patients included in this study also had a diagnosis of paroxysmal AF, and it is not clear whether the AF occurred intraoperatively or on postoperative day 0. IOAF, although often transient during LTx, remains an important prognostic indicator associated with mortality and increased length of stay[5].

Patients undergoing LTx often have factors predisposing to AF. The pathophysiology associated with IOAF appears multifactorial and needs to be fully understood. However, several mechanisms have been proposed to explain the occurrence of this phenomenon. Among the possible causes, activation of the sympathetic system and autonomic imbalance are the most recognized mechanisms that increase susceptibility to AF, intraoperatively and postoperatively[10]. Therefore, the occurrence of new-onset AF may occur in the anhepatic phase due to the high demand for inotropic medications during this stage of LTx[10].

Other mechanisms are related to the development of AF during LTx, including surgical stress, elevated catecholamine levels, sudden exposure to cold, cardiac dysfunction, and preexisting pericardial inflammation. Increased sympathetic tone may reduce the atrium refractory period, potentially contributing to the emergence of IOAF[10]. Furthermore, acidosis, hypo/hyperkalemia, hypocalcemia and hypoglycemia, as well as hypothermia during liver transplantation, can also induce AF. Higher MELD score and fulminant hepatic failure were associated with IOAF[9].

Moon et al.[10] observed that seven cases of IOAF occurred during graft reperfusion. The reperfusion phase is when hepatic blood flow is restored, a critical period of great hemodynamic instability[10]. A drop in blood pressure and systemic vascular resistance characterizes this period. The hemodynamic response occurs due to the sudden release of acidotic, hyperkalemic blood rich in vasoactive substances and the byproducts of the ischemia process[15]. Additionally, hypothermia occurs due to the high influx of cold preservation solution into the liver graft[10].

In the study conducted by Li et al.[9], AF occurred during dissection of the recipient's liver immediately after bolus administration of ice-cold saline and 8 μg of norepinephrine. However, it is believed that AF is not directly related to the administration of norepinephrine, as reports of AF using low doses of norepinephrine during surgical procedures are rare. On the other hand, the sudden influx of cold saline solution can cause atrial stretching, contributing to the onset of AF. Furthermore, cooling the sinoatrial node can interfere with cardiac rate and output, causing hemodynamic dysregulation that can predispose to AF[9].

In the clinical case outlined by Prakash et al.[8], the patient in question had a history of chronic alcoholism; however, no evidence of preexisting cardiac comorbidities, such as ischemic heart disease, cardiomyopathy, or preexisting AF, was identified. In the present study, significant blood loss and high doses of vasopressors were observed, which may have contributed to a pro-arrhythmogenic state. Furthermore, the additional increase in vasopressor support during the anhepatic phase likely exacerbated the condition[8].

Most research focuses on the emergence of AF in the postoperative period of LTx, with few studies addressing the occurrence of AF during the surgical procedure. The incidence and characteristics of IOAF in LTx still need to be better understood, with limited discussion on this topic in the literature. The prevalence of this event has yet to be established.

Postoperative Atrial Fibrilation (POAF)

POAF represents the most prevalent cardiovascular complication after LTx, characterized by the emergence of AF within an average period of 30 days after surgery[6]. The incidence of POAF varies according to the type of surgical procedure performed and the patient's clinical particularities. POAF can occur in up to 60% of cardiac or thoracic surgery cases due to pericardium manipulation and cardiac innervation stimulation. Patients undergoing LTx often have an inferior health status compared to other groups of patients, resulting in a high incidence of POAF, even though it is not thoracic surgery[16].

In the study by Xia et al.[5], the POAF rate in liver recipients was 7.9%. Koshy et al.[6] reported the presence of POAF in approximately one in every 10 patients undergoing LTx. In another study, the incidence of POAF was 10% after LTx. Furthermore, its occurrence was observed in 11% of cases after abdominal surgeries[13]. Advanced age is recognized as a significant risk factor for emerging new-onset AF[5,6,11,13,14]. Studies similar to the one conducted by Jiang et al.[17] demonstrated a 1.8-fold increase in the risk of POAF for each 10-year increase in age. Additional factors, such as male sex, obesity, prior history of AF, and poor physical status, have been consistently associated with increased risk.

Similarly, in the study conducted by Xia et al.[5], analysis revealed that with each decade after age 50, the chances of developing POAF increased almost twice[5]. In recent decades, there has been a considerable increase in the proportion of patients over 50 undergoing LTx. Consequently, the incidence of perioperative AF is expected to increase over time. In addition to age, the presence of a low physiological reserve and an underlying substrate of cirrhotic cardiomyopathy is also associated with increased incidence[6,18].

Factors related to the surgical procedure also influence the incidence of AF. The open surgical approach commonly used in LTx and the prolonged procedure time are linked to the occurrence of this complication. LTx is recognized as one of the most extensive surgeries, with considerable surgical time, contributing significantly to this incidence[17,19]. Surgical stress, adrenergic stimuli, and systemic inflammation can trigger the activation of the autonomic nervous system. Furthermore, electrolyte imbalances, such as hypokalemia worsened by changes in fluid balance during surgery, are also associated with an increased risk of POAF due to modifications in cardiac cell electrical characteristics, automaticity, and excitability[19].

Patients with liver disease are often considered to have low cardiac comorbidities, with treatment focusing on controlling associated renal dysfunction and coagulopathy. However, recent studies, such as that by Huang et al.[20], suggest that patients with cirrhosis have a high risk of AF, a risk that increases as the MELD score rises. The prevalence and incidence of AF increase in patients with a higher MELD score. The prevalence of AF was 3.7, 6.4, 16.7 and 20.2%, corresponding, respectively, to the MELD quartiles 1 to 10, 11 to 20, 21 to 30 and above 3020. In the study by Xia et al.[5], it was observed that patients with a higher MELD score have a more complicated perioperative evolution, a higher incidence of preoperative comorbidities and a greater need for vasopressors[5].

Lee et al.[21] observed a relatively higher risk of AF, up to 46%, in cirrhotic patients compared to non-cirrhotic patients. According to Mozos et al.[18], The mechanisms that explain the presence of AF in patients with liver cirrhosis occur due to electrolyte dysregulation, hepatorenal syndrome, high concentration of bile acids in the bloodstream, metabolic abnormalities and inflammatory syndromes[18].

Chronic liver disease may have a direct or indirect influence on the pathogenesis of AF. Vagus nerve fibers innervate the portal vein, hepatic arteries, bile ducts and liver parenchyma. In cirrhosis, denervation of the liver parenchyma may occur, contributing to dysfunction in autonomic regulation. Thus, abnormal neurotransmission, with hyperactivation of the sympathetic and parasympathetic systems, is related to rhythmic dysregulation of the heart and, consequently, to the occurrence of AF[20].

Hyperactivity of the sympathetic system is correlated with increased production of inflammatory cytokines, such as interleukin-1 beta, interleukin-6, interleukin-8, tumor necrosis factor alpha [tumor necrosis factor-alpha (TNF-α)] and transforming growth factor beta [transforming growth factor beta (TGF-β)]. Hepatitis C virus infection can be seen in patients with dilated and hypertrophic cardiomyopathy and may play a role in the pathogenesis of these conditions and cause cardiac arrhythmias. AF and AFL are arrhythmias diagnosed in cirrhotic patients and are significantly associated with the presence of arteriosclerosis, hypercholesterolemia and diabetes mellitus[18].

Concerning morbidity and mortality, an increase in mortality and length of hospital stay was observed in several studies[10-14]. Rachwan et al.[13] reported that mortality rates after 90 days and 1 year were considerably higher in groups of patients with POAF compared to those without POAF. These results were consistent with the findings of Xia et al.[5], who also identified a significant increase in mortality rates at 1, 3 and 6 months in patients with POAF when compared with controls.[5]

Another adverse outcome associated with perioperative AF, as evidenced in studies, was the length of hospital stay[2,10]. Previous studies have also demonstrated the association between POAF and higher intensive care unit readmission rates after LTx[13]. An earlier study showed that POAF was associated with a higher intensive care unit readmission rate after LTx.

Most episodes of POAF were self-limited or resolved with treatment. This phenomenon may indicate a poor prognosis for subsequent cardiovascular complications.[2,13].

CONCLUSION

AF in the perioperative period of liver transplantation is still an underestimated issue and little addressed in the scientific literature. However, available evidence indicates that its occurrence is linked to patients with higher MELD scores, advanced age, liver failure and hemodynamic and electrolyte instabilities during the intraoperative period. Regardless of duration, this dysrhythmia is associated with underlying medical conditions. Therefore, preventive strategies and management protocols must be implemented during the perioperative period to mitigate the risks associated with this cardiac complication and improve the patient's clinical outcomes.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Fonseca Neto OCL, Cardoso RMV; **Conception and design:** Fonseca Neto OCL, Cardoso RMV; **Data analysis and interpretation:** Fonseca Neto OCL, Cardoso RMV; **Article writing:** Fonseca Neto OCL, Cardoso RMV; **Critical revision:** Fonseca Neto OCL, Cardoso RMV; **Final approval:** Cardoso RMV.

DATA AVAILABILITY STATEMENT

All dataset were generated or analyzed in the current study.

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