Research Article

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The Role of Alcohol Ablation Therapy in Hypertrophic Obstructive Cardiomyopathy Management

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Abstract

Objectives: *The following study aims to investigate alcohol septal ablation's (ASA) role in hypertrophic obstructive cardiomyopathy (HOCM) management, focusing on in-hospital outcomes, efficacy in reducing left ventricular outflow tract (LVOT) obstruction, and safety profiles.*

Methods: *The study, conducted at the Institute of Cardiology, National Hospital of Sri Lanka, included a total of nine HOCM patients. Participants with exercise-induced symptoms, dyspnea/angina, and specific ventricular gradients were included; unidentified septal branches led to exclusion. Diagnostic assessments, including electrocardiogram, contrast echocardiography, and cardiac catheterization, confirmed HOCM. ASA procedures involved careful target septal branch selection, alcohol injection, and post-procedure care with temporary pacemaker monitoring.*

Results: *The study population (N=9) comprised seven males and two females, with a mean age of 40. Pre- and post-ablation measurements showed 78% reduction in LVOT gradient. Immediate complications included chest pain (100%), while 22.2% developed complete heart block. Notably, no mortality occurred during the study.*

Conclusion: *ASA proved safe and effective in managing HOCM, with significant mean reduction in post-ablation LVOT gradient (78%). Complications were generally minor, emphasizing ASA's viability for symptomatic HOCM patients. While acknowledging the absence of randomized controlled trials comparing ASA with alternative techniques, this study contributes valuable insights to guide collaborative treatment decisions by specialists.*

Keywords: Cardiomyopathy, Hypertrophic, Alcohol Ablation.

Introduction

Background

Hypertrophic obstructive cardiomyopathy (HOCM) is considered the most common inherited cardiovascular disease, affecting approximately one in 500 individuals. (Maron, & Maron, 2013). Characterized by reduced venous return, HOCM leads to diminished left ventricular filling, causing an increase in the intraventricular gradient and obstructing the outflow tract during systole. (Kern, 2018).

Diagnostic methods, including echocardiography (ECHO), catheterization, (Gersh et al., 2011) and genetic testing, (Maron et al., 2003) play crucial roles in the diagnosis and assessing HOCM. Patients who meet any of the established risk criteria—sudden death in one or more first-degree relatives, maximal left ventricle (LV) wall thickness ≥30 mm, or a recent, unexplained syncopal event—should be evaluated for ICD implantation. (Trivedi & Knight, 2016).

Treatment strategies aim to alleviate symptoms, prevent complications, and enhance overall quality of life. Conservative measures involve non-vasodilating beta blockers or verapamil, while refractory cases may consider invasive procedures such as alcohol septal ablation (ASA). (Hoedemakers et al., 2019). The first report of selective ASA was made in 1995 by Dr. Sigwart. (Spencer & Roberts, 2000). Initial results indicate symptom relief, rapid recovery, low short-term mortality, and sustained improvement over time. (Maron, & Maron, 2013). However, not all patients are suitable candidates for ASA, as per recommendations that consider factors such as age, comorbidities, and patient preferences. (Spirito et al., 2017). The technique involves injecting specific amounts of absolute ethanol into a septal artery that supplies the LV of the basal or mid-cavitary septum, usually the first or second septal perforator branch. (Pelliccia et al., 2021).

Justification

The following study addresses the pressing need for effective management strategies for HOCM, with a focus on ASA: a therapeutic avenue offering symptom relief and sustained improvement. Our study conducted at the Institute of Cardiology, National Hospital of Sri Lanka, investigates the role of ASA in HOCM management.

Objectives

General Objective

The general objective of this study is to investigate and evaluate the role of alcohol ablation therapy in the management of hypertrophic obstructive cardiomyopathy.

Specific Objectives

The specific objectives of this study include;

1. To provide insights into the in-hospital outcomes of ASA
2. To determine the efficacy of ASA in reducing left ventricular outflow tract (LVOT)
3. To assess the safety profiles for complications of ASA

Methodology

The study setting is based in the Institute of Cardiology, National Hospital of Sri Lanka, and was conducted from November 2021 to January 2023.

Patient Selection

The study population was selected based on the following inclusion criteria: recurrent exercise-induced pre-syncope or syncope, dyspnea or angina of New York Heart Association/ (Fisher, 1972) Canadian Cardiovascular Society functional class III or IV, (Campeau, 1976) and left ventricular gradients ≥30 mm Hg at rest or ≥50 mm Hg at provocation (Valsalva maneuver or post-extrasystolic potentiation). Patients with unidentifiable target septal branches were excluded from the study. The study population included a total of nine patients after the above criteria was applied. Before intervention, all patients were provided with written informed consent, following thorough discussion of the available therapy options.

HOCM Investigations

Electrocardiogram (ECG), contrast ECHO, and cardiac catheterization was completed on all the patients for the confirmation of HOCM diagnosis. Patients with HOCM demonstrated distinctive ECG features, including high QRS voltage (e.g., Sokolow criteria), repolarization abnormalities, and ventricular or atrial arrhythmias. During the ECHO examination, patients with HOCM were characterized by ventricular hypertrophy, often exceeding 15mm, with a predilection for the septum over the lateral wall. Dynamic obstruction occurred through LVOT gradient or systolic anterior motion (SAM) of the mitral valve. Abnormal diastolic function, atrioventricular valve regurgitation, and atrial enlargement were common features. Abnormal systolic function was also observed during severe cases.

Cardiac catheterization for HOCM uncovered the typical triad known as the Brockenbrough-Braunwald-Morrow sign during post-extrasystolic heartbeats. The Brockenbrough-Braunwald-Morrow phenomenon is a useful technique to record the degree of dynamic LVOT obstruction in perioperative ASA and it can confirm the resolution of obstruction following the intervention in patients without evidence of resting obstruction. (Bello et al., 2019). Additionally, an elevation in the gradient between the left ventricle and aorta, a reduction in systemic blood pressure, and a constriction of the pulse pressure.

ASA Procedure

Alcohol ablation therapy was performed in the cardiac catheterization laboratory located in the Institute of Cardiology, National Hospital of Sri Lanka. The following procedures were followed in our institution.

In order to lower the risk of heart block, we ceased beta blockers and calcium channel blockers 24 hours prior to the procedure. A temporary pacemaker (TPM) was inserted. The left coronary system was engaged with the left guide catheter (EBU/XB). Septal perforator arteries were identified by performing a left coronary angiogram. Heparin 100 mg/kg was administered intravenously.

Target Septal Branch Selection

The targeted artery was determined by conducting intraprocedural contrast ECHO with agitated Hartman or Gelafundin. The septal branch was wired with a standard work course wire. The proximal part of the septal branch was occluded with an appropriately chosen (1.5/2x8/10mm) over-the-wire balloon with nominal pressure. Then, 2-3ml of Gelafundin or agitated Hartman was administered through the central lumen of the over-the-wire (OTW) balloon after removing the guidewire. Detailed contrast echocardiography was performed to identify the septal-mitral contact point another area of enhancement. After identifying the target septal artery, a septal angiogram was performed in the same manner as an echo contrast injection to identify collateral flow into other vessels and cavities or chambers, and to assess the risk of a leak or slippage of the balloon during alcohol injection.

Alcohol Injection & Removal of the Balloon

Sedation was administered before alcohol injection, the target artery was threaded with a coronary wire, and the proximal artery was blocked using an OTW balloon inflated above nominal pressure. A slow injection of 2-3ml of absolute alcohol was carried out over 2-3 minutes, followed by 0.5ml of saline. The balloon remained inflated for 5 minutes to allow the target area of the septum to marinate. Subsequently, the balloon was deflated, and continuous aspiration of the central lumen was performed until the balloon was completely removed from the body. A left coronary angiogram was conducted to confirm the occlusion of the septal artery and the patency of the left main coronary artery (LMCA) and left anterior descending artery (LAD). Post-procedure echocardiography was performed to assess the LVOT gradient and identify complications such as acquired ventricular septal defect (VSD).

Post-Procedure Care

The patients were admitted to the coronary care unit and were monitored for a period of 72 hours. TPM was removed after 24 hours. However, a permanent pacemaker (PPM) was installed if complete heart block (CHB) was detected within 72 hours post-ASA procedure.

Results

The sample size (N=9) involves a total of seven males and two females. The ages across the study population ranged from 31 to 63 years, and the mean age was recorded as 40.

The left ventricular systolic blood pressure (LV-SBP), aortic systolic blood pressure (Ao-SBP), and LVOT gradient were measured and recorded for each patient during pre-ablation and post-ablation stages (Table 1). The means of LV-SBP, Ao-SBP, and LVOT gradient values among all patients were calculated (Table 2).

No	Date	Age	Gender	Pre- Ablation			Post-ablation			Post-ablation TTE-gradient	Immediate post-Op complication
				LV-SBP	Ao-SBP	Gradient	LV-SBP	Ao-SBP	Gradient		
1	01/11/21	49	M	120	100	20	98	90	8	10	Chest pain
2	09/12/21	60	F	198	124	74	148	128	20	44	Chest pain, RV puncture during TPM insertion, Pericardial effusion (ended up with open surgery and Pericardial patch)
3	13/01/22	34	F	120	100	20	98	90	8	10	Chest pain
4	31/03/22	37	M	200	84	116	120	117	3	30	Chest pain
5	04/07/22	36	M	160	90	70	115	95	20	40	Chest pain
6	21/07/22	34	M	165	90	75	140	100	40	40	Chest pain
7	21/10/22	63	M	180	140	40	140	140	0	18	Chest pain
8	19/01/23	31	M	160	105	55	95	91	4	15	Chest pain, Permanent CHB, Ended up with PPM
9	19/01/23	36	M	161	83	78	130	117	13	17	Chest pain

Table 1: Summary of patient data

LV-SBP= left ventricular systolic blood pressure; Ao-SBP= aortic systolic blood pressure; TTE= transthoracic echocardiogram; post-Op= post-interventional; RV= right ventricular, TPM= temporary pacemaker; CHB= complete heart block; PPM= permanent pacemaker

	Pre-ablation Mean ± SD	Post-ablation Mean ± SD
LV-SBP (mmHg)	160.4 ± 13.4	120.4 ± 11.2
Ao-SBP (mmHg)	101.8 ± 3.7	107.6 ± 7.9
Gradient (mmHg)	60.9 ± 17.8	12.9 ± 4.1

Table 2: Pre-ablation Vs post-ablation comparison between LV-SBP, Ao-SBP, and gradient

LV-SBP= left ventricular systolic blood pressure; Ao-SBP= aortic systolic blood pressure

The distribution of immediate post-procedural complications, as illustrated in Figure 1, reveals that all nine patients complained of chest pain. Among them, two patients developed CHB One of these individuals suffered a right ventricle puncture during temporary pacemaker insertion, resulting in pericardial effusion and subsequent cardiac tamponade. This complication necessitated open-heart surgery and the placement of a pericardial patch. Moreover, it should be emphasized that no mortality was observed throughout the entire study period.

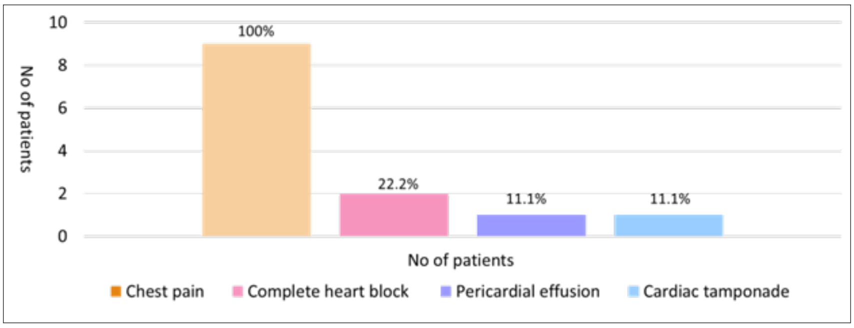

Figure 1: Distribution of various complications among patients

Discussion

The characteristics of HOCM were initially delineated by Alfred Vulpian, with the condition originally termed as "idiopathic hypertrophic subaortic stenosis". Subsequently, Teare's work laid the foundation for recognizing HOCM as a distinct clinical entity. (Teare, 1958). Over the past 50 years, HOCM has been identified as a diverse genetic heart condition, significantly contributing to sudden arrhythmic death, heart failure, and atrial fibrillation leading to embolic stroke. (Maron & Maron, 2013). Several studies have indicated that ASA serves as an effective minimally-invasive management option for HOCM patients, (Veselka et al., 2016) reducing LVOT obstruction and alleviating symptoms. (Sorajja et al., 2012). Surgical myectomy is another effective treatment employed for HOCM patients experiencing symptoms despite medical intervention. However, studies have found that ASA is less likely to be linked to lower periprocedural mortality and stroke when compared to myectomy. Hence, our study aims to contribute in expanding the literary knowledge by exploring the therapeutic effects of ASA in HOCM management.

A total of nine patients (N = 9) made up the population sample, with male patients accounting for the majority (77.8%). A similar study conducted has also observed a male dominance in HOCM patients. (Batzner et al., 2018).Therefore, it can be stated that this study reflects the gender distribution in HOCM when compared with existing literature. Despite the evidence of historical data displaying male predominance in diagnosed cases, (Maron & Maron, 2013) males and females have an equal chance of developing HOCM, according to studies that have focused on gender differentiation. (Butters et al., 2021). The mean age of the study population is rounded to the nearest whole number, resulting in 42 years old, with a range between 31 and 63 years. In contrast to our research, multiple sources in the body of current literature have claimed that individuals aged over 50 are usually more vulnerable to HOCM. (Hoedemakers et al., 2019; Batzner et al., 2018; Batzner et al., 2021). It was hypothesized that the small sample size used for the study population caused this contradiction.

In this study, the LV-SBP, Ao-SBP, and LVOT gradients were measured twice: pre-ablation and post-ablation, to evaluate the effects of ASA intervention on each patient. The evaluation of the above-mentioned parameters offers important insights into the operations of the aorta (Ao), left ventricle (LV), and their interactions. Abnormalities of these values can be indicative of various cardiovascular conditions. (Kobayashi et al., 2018). In HOCM, the LVOT becomes obstructed due to the thickened LV and dynamic mitral valve movement. This obstruction significantly impacts intracardiac pressures and blood flow, leading to changes in LV-SBP, Ao-SBP, and the LVOT gradient. (Maron & Maron, 2013).

For analytical purposes, the means for LV-SBP, Ao-SBP, and LVOT gradients were calculated in order to generalize the findings among the total population (Table 2). After observation, it was evident that the study population's mean LV-SBP was increased (μ=160.4) when compared to a healthy individual. LV-SBP elevation is a common phenomenon that is associated with HOCM. This is due to the narrowing of LVOT which forces the LV to generate a greater force. (Butters et al., 2021; Basit et al., 2024). However, the mean LV-SBP was significantly diminished to reach normal values (μ=120.4) when measured post-ablation. Our findings coincide with multiple literary sources where ASA intervention was used to alleviate LVOT obstruction, (Pelliccia et al., 2019) and provide significant reductions in LV-SBP leading to improved symptoms and exercise tolerance. (ten Cate et al., 2010).

Ao-SBP has not been directly affected by increased LVOT gradient, therefore the mean pre-ablation Ao-SBP among the study population (μ=101.8) has remained within the normal range. This is because Ao-SBP is primarily determined by the strength and volume of blood ejected by the LV and resistance of the peripheral arteries. (Kobayashi et al., 2018). However, some studies have found that HOCM can result in a lower Ao-SBP due to the increased workload exerted on LV. (Ragosta, 2009). It is possible to conclude from the analysis of the data that the mean Ao-SBP level (μ=107.6) of the patients in our study was not significantly affected by the ASA intervention.

The mean pre-ablation LVOT gradient was elevated among the study population (μ=60.9). This is due to the thickened LV wall that narrows the outflow tract, significantly increasing the pressure gradient during contraction. (Geske et al., 2009). However, the intervention of ASA yielded outstanding results where the mean post-ablation gradient was reduced by 78% (μ=12.9). Concurrently, similar studies show a substantial reduction in the LVOT gradient which translates to clinical improvement in symptoms such as shortness of breath, fatigue and chest pain following the ASA procedure. (Batzner et al., 2018). This is because ASA reduces the localized infarction of the septal myocardium and the obstruction of the outflow tract by injecting alcohol into the appropriate septal artery. (Knight, 2006).

Moreover, the study employed a 3-day observation period for each patient to record post-op complications. It was evident that all patients (n=9) developed chest pain following the ASA procedure. Out of the population, 22.2% of the patients developed CHB within 72 hours: post-ASA. A single-center-study conducted in 2021 suggests CHB as the second most common conduction abnormality noted post-ablation; usually within the first 24-hour window, with right bundle branch block (RBBB) being the most prevalent complication. (Mani et al., 2021). However, RBBB was not recorded within our study. Pericardial effusion: which is considered a rare complication, was reported in a single patient during the study period. A recently published case report describes of a possibility where pericarditis may occur in 7% of ASA interventions. (Motoki et al., 2023). A case of cardiac tamponade, another uncommon occurrence that can happen during catheter ablation, was also reported in our study. Patients in these situations need emergency care and might need sternotomies or percutaneous pericardial drains. (Khan, 2023). Above all, it is crucial to note that no mortality was reported for the entirety of our study period.

Conclusion

After the completion of the study, it was evident that ASA is a safe and effective treatment for HOCM in patients with persistent symptoms despite optimal medical therapy. Our two-year study found minimal complications, with post-procedural chest pain being the most common among the patients. The study displayed 78% mean reduction in post-ablation pressure gradient with no mortality observed throughout. In the absence of randomized controlled trials contrasting ASA with alternative techniques: such as myectomy, the optimal course of treatment for each patient should be determined collaboratively by a team of specialists.

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