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Review Article

Adverse Effects and Limitations of Adenosine in Treatment of Narrow QRS Complex Tachycardia (NCT) and Broad Complex Tachycardia (BCT): A Systematic Review

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ABSTRACT

There has been always a need to unlock the key to a different kind of tachycardia, tachyarrhythmias, in short, Narrow complex tachycardias {which includes Atrioventricular nodal reentrant tachycardia (AVNRT), Atrioventricular reciprocating tachycardia (AVRT), Nonparoxysmal junctional tachycardia (NPJT), Orthodromic Reciprocating Tachycardia (ORT), Permanent junctional reciprocating tachycardia (PJRT)} which also lead to broad complex tachycardias, it's appropriate management at that juncture with the consideration of all the adverse effects and limitations, with Adenosine and verapamil, while taking into consideration the contraindications of both the adenosine, the calcium channel blockers (verapamil/diltiazem) used for the chemical conversion of Supra Ventricular tachycardia (SVT) even when the accessory pathways are involved. The use of the drugs as a diagnostic tool be it the presence of latent pre-excitation, fasciculo-ventricular pathway, and unmasking the dual atrioventricular (AV) nodal physiology along with the treatment tool has also been discussed. On February 10, 2023,

many databases, including PubMed, Google Scholar, and the Cochrane Library, were used to search the chosen studies. The chosen papers for this review were released up until 2014. The PRISMA flow diagram included a description of the systematic search. 6,542 articles were initially identified for the chosen databases. After the manual selection of papers and quality evaluation of the essential articles, 10 articles were ultimately picked for the thesis' foundation. Randomized Control Trials (RCTs) are evaluated for quality using the Cochrane bias assessment tool, the Prisma checklist for systematic reviews, the JB check tool for case reports, and the Newcastle Ottawa tool for non-randomized clinical trials.

There are three aspects covered, which are the methods of administration, complications post-adenosine administration, and effectiveness & adverse effects of adenosine & Calcium Channel Blockers in Supra Ventricular Tachycardia. Comparison of the success rate, adverse effects, and conversion rate and its interpretation through the selected articles. Success rates for Adenosine and Verapamil are compared. Comparison of adenosine injection techniques' rates of success. Comparison of adenosine administration difficulties experienced by participants in various studies. Comparison of the issues faced by participants in several studies who took Verapamil through graphical representation. Comparatively, Adenosine has been found as the superior drug, irrespective of increased side effects due to its short half-life (approx. nine seconds) and fast conversing action, leading to an increased success rate. It can be concluded that Shortness of breath (SOB) and flushing have both significantly impacted complications. It is followed in descending order by nausea, vomiting, chest pain, bradycardia, and the remaining problems. On the other hand, side effects from taking verapamil show that hypotension is the most commonly impacted, followed by shortness of breath and other side effects.

Keywords: Supraventricular Tachycardia; Success rate; Complications; Verapamil; Adenosine; Limitations; Adverse effect; Tachycardia

INTRODUCTION AND BACKGROUND

The presence of a QRS complex length of less than 120 ms and a heart rate of greater than 100 beats per minute on a twelve - lead electrocardiogram (ECG) designates a narrow complex tachycardia (NCT), which is often of supraventricular origin.[1] Broad complex tachycardia (BCT) might create diagnostic and treatment challenges when it occurs in the emergency department (ED).[2] Adenosine-induced atrioventricular block reduces the ventricular rate and shows the unaltered atrial arrhythmia in tachycardias of atrial origin, and it can terminate re-entrant supraventricular tachycardias that involve the atrioventricular node.[3] Adenosine should have the greatest usefulness as a diagnostic and treatment tool for broad complex tachycardias (which are frequently misdiagnosed) because it affects supraventricular tachycardias with aberrant conduction but has no impact on ventricular tachycardia.[3] The adenosine A1 receptor is directly activated, which mediates the majority of the antiarrhythmic actions on the Sinoatrial (SA) node, AV node, and atrial myocytes. Adenosine increases the outward potassium current when it binds to this receptor.[4] The action potential duration is decreased and the cardiac cell membrane becomes hyperpolarized as a result of this increase.[4] The threshold for inducing a second action potential rises with

hyperpolarization of the sinus node and AV nodal cell membranes, substantially above their predicted resting membrane potential, decreasing cell activity.[4]

At a heart rate of greater than 100 bpm, wide QRS tachycardia is defined by a QRS duration of more than 120 milliseconds.[5] On the electrocardiogram, it causes noticeable changes in lead V1: These electrocardiographic modifications may look similar regardless of the cause of slow conduction, which may be functional (temporary) or structural (permanent) due to scar and when the impulse comes from the myocardium or travels through it to reach the His-Purkinje system, producing a broad QRS complex, the rate of conduction will likewise be slowed.[5] When canon A waves are present during WQRST, Atrioventricular (AV) dissociation is likely to be taking place. The tricuspid valve may shut during atrial systole during AV dissociation, causing the jugular venous pulse to show significant "a" waves (canon A waves).[5]

The annual incidence of Supraventricular tachycardia (SVT) is 36 per 100,000 people, and women are twice as likely to get it as males.[6] The American Heart Association (AHA) suggested using 6 mg for the first dose and 12 mg for the second dose of adenosine for tachyarrhythmia 2015 and guidelines state that to let adenosine reach the heart more quickly, the arm should be raised immediately after delivery through the right antecubital fossa's proximal intravenous (IV) peripheral line at a 90° angle.[6] Even when AV block does not occur as a result of adenosine administration, there may be unfavorable short-term mild problems and no major adverse events, such as flushing, dyspnea, headache, bradycardia, and chest tightness.[6]

Adenosine is useful for diagnosing narrow QRS complex tachycardia patients because it causes conduction obstruction in the AV node and is essential for pulmonary vein isolation as well as for revealing the accessory route conduction both before and after ablation.[7] In the heart, G-protein-coupled adenosine receptors (GPCRs) are primarily found in two forms: A1 on cardiomyocytes, which is in charge of its electrophysiological effects, and A2 on endothelial and vascular smooth muscle cells, which controls coronary vasodilation.[7] Adenosine combined with A1 receptors decreases the activity of the sinoatrial (SA) node, AV nodal conduction, and atrial contractility.[7]

Due to the relative competing conduction velocities in the AV nodal (faster) and accessory pathway (slowly conducting) or the significant distance of the accessory pathway (left lateral pathway) from the SA node, it is frequently challenging to distinguish the delta waves (pre-excitation) in patients with a suspicion of an accessory pathway.[7] To increase conduction through the accessory channel, adenosine prolongs AV nodal conduction (Atriofascicular pathways or PJRT are the only accessory routes that are typically affected by adenosine).[7] To determine fasciculo ventricular routes, Suzuki T et al employed the adenosine test when either an AV block occurred without a change in the QRS waveform or the PR interval was prolonged by more than 40 msec without a change in the QRS shape.[7] The fasciculo ventricular pathway typically exhibits a lack of responsiveness to adenosine in the presence of a PRKAG2 mutation and develops sinus bradycardia without AV block.[7] Adenosine injection can reveal dual AV nodal physiology when it occurs in sinus rhythm. Adenosine can also seldom cause AV nodal reentrant tachycardia.[7] Due to the barrier in the fast pathway and the switch to the slow pathway, dual AV node physiology shows an abrupt increase in the PR interval.[7] With a significant negative predictive value, a single dose of intravenous adenosine (12 mg) during sinus rhythm can detect dual AV node physiology in the surface ECG recording at the bedside in patients with verified narrow QRS tachycardia without evident preexcitation.[7] Either a

PR leap (greater than 50 msec) or an AV nodal echo (a retrograde P wave at the end of the QRS complex) indicates a positive adenosine test.[7] Figure 1 states the mechanism of action of Adenosine's Cyclic adenosine 3′,5′-monophosphate (cAMP) -dependent or independent impact on Cardiac myocytes via A1 receptors.

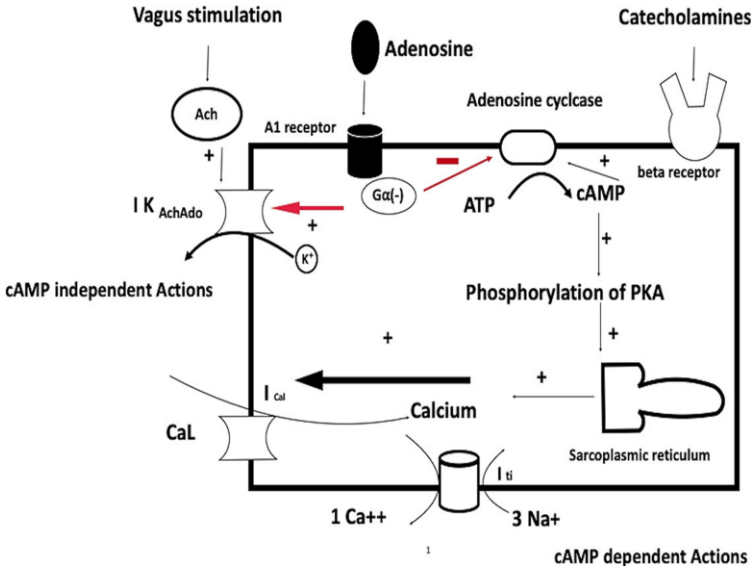

Figure 1: Mechanism of action of Adenosine on cardiac cells. Adenosine can have a cAMP-dependent (Cyclic adenosine 3′,5′-monophosphate) or independent impact on cardiac cells via A1 receptors.[7] Phase 4 depolarization and ICaL inhibition are both cAMP-dependent processes, but the activation of potassium channels (negative chronotropic and dromotropy) is cAMP-independent.[7]

Method:

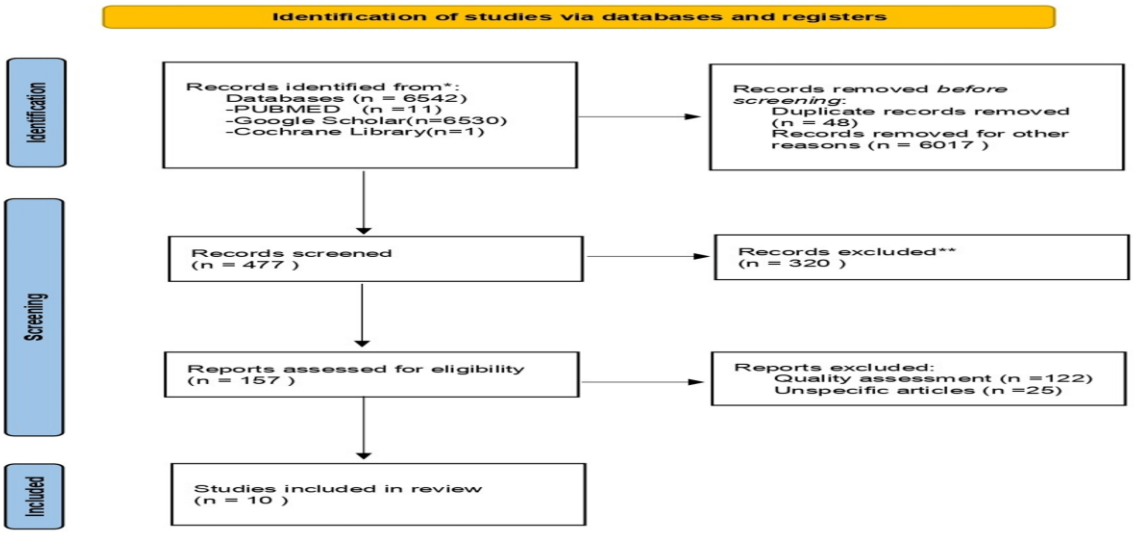

Figure 2: Prisma flow chart for screening process.

This systematic review includes four Randomized control trials, three case reports, two systematic reviews, and one literature review.

Searching databases:

The selected studies were searched by using different databases including PubMed, Google Scholar, and Cochrane Library on February 10, 2023. Therefore, all the selected study data was published reports and published in English. The literature search technique comprises the following search phrases: ("Adenosine/administration and dosage"[Mesh] OR "Adenosine/adverse effects"[Mesh] OR "Adenosine/agonists"[Mesh] OR "Adenosine/antagonists and inhibitors"[Mesh] OR "Adenosine/metabolism"[Mesh] OR "Adenosine/pharmacology"[Mesh] OR "Adenosine/physiology"[Mesh] OR "Adenosine/therapeutic use"[Mesh] OR "Adenosine/toxicity"[Mesh]) AND ("Tachycardia/chemically induced"[Mesh] OR "Tachycardia/diagnosis"[Mesh] OR "Tachycardia/diagnostic imaging"[Mesh] OR "Tachycardia/drug therapy"[Mesh] OR "Tachycardia/physiopathology"[Mesh]). All essential article references were scanned, and any other research that could be of interest was obtained for future investigation. Meanwhile, the selected papers for this review were published up to 2014.

Criteria of the selected study:

Initially, the studies were selected by using different search items as well as a screening process. The first step of screening involves the automatic elimination of any duplicate studies by using the 2023 Clarivate Endnote software. Therefore, the titles and abstracts of studies that didn't match the inclusion criteria were discarded. The full-text editions of the relevant articles were included during the screening process. The studies were selected based on Inclusion Criteria, which included, firstly, patients who suddenly developed SVT with predisposed heart conditions such as myocardial infarction, post-PCI, and CABG patients, or other diseases. Secondly, Adenosine or Calcium channel blockers (Verapamil or diltiazem) as an intervention group where the drug of choice for treatment in the emergency setting, is the difference in effectiveness and evaluation. Thirdly, the side effects of the pertinent drugs and their limitations. Furthermore, all the papers were written in the English language. The age of selected participants in the considered reviews and RCTs are all adults above 18 Years and older. Full texts were included for the study and publication date was within 10 years (2014-2024).

However, the studies were discarded based on the exclusion criteria followed by ventricular tachycardia in a stable patient, electrocardiogram undone, any animal or cell culture studies, studies that did not meet the conclusive efficacy endpoint, or any papers before 2014.The outcome of the selected studies.

Quality assessment:

The Cochrane bias assessment tool is used to quality assess Randomized Control Trials (RCTs), the Prisma checklist for systematic review, the JB check tool for case reports, and the New Ottawa tool.

Search strategy:

The summary of the systematic search and screening is been sketched and depicted in Figure 2 in the PRISMA flow diagram. Initially, 6542 articles were identified for, the selected databases, which are 11 from PubMed, 6530 from Google Scholar, and 1 from Cochrane Library which were selected using relevant topics by using different search keywords from different databases. Afterward, 6017 articles were removed for other reasons as they were not concerning my topic and 48 articles were removed for duplication by using 3023 Clarivate Endnote software. Furthermore, 477 articles were screened based on title and abstract. Thereafter, 320 articles were excluded and 157 remained based on Inclusion and exclusion criteria of which, 122 were excluded based on quality assessment (poor quality articles) and 25 were unspecified articles. Finally, 10 articles were chosen for the build-up of the thesis after the manual selection of articles and quality assessment of the pertinent articles.

DISCUSSION

Author and year of publication	Drug studied	Control	Number of patients	Type of Study	Complications	Result	Conclusion
Daengbubpha et al, 2022 [8]	Adenosine (Alternative method)	Standard method	30 [15+15]	RCT	-*Standard method*- Palpitations (1/15) -*Alternative method*- Light-headedness (1/15)	Termination success- 13/15 (86.7%) in the Alternative method. 12/15 (80%) in the Standard method.	The success rate is the same in both cases [8].
Makhubela et al, 2018 [9]	Adenosine (Simplified method)	Standard (AHA) method	151 [94+47]	RCT	-*Standard method*- Shortness of breath, flushing, dizziness -*Simplified method*- No	-*Standard method (AHA)*- 80% success rate -*Simplified*	Statistically, the change was not significant (p = 0.39). The patients who got adenosine via the

					complications	*(convenient) method*- 85.7% success rate	"convenient" method did not experience any severe side effects [9].

Table 1: Methods of administration

Author and year of publication	Drug studied	Number of patients	Type of Study	Complications	Diagnosis	Result	Conclusion
Daengbubpha et al, 2022 [8]	Adenosine	30 [15+15]	RCT	-*Standard method*- Palpitations -*Alternative method*- Light-headedness, syncope		1 patient from each group had complications in one minute	There is no proof that alternative and standard methods differ in terms of ECG response success rate or problems within the first minute following adenosine administration [8].
Lee et al, 2021 [9]	Adenosine	1	Case Report	GTC seizure, absent pulse, and Ventricular fibrillation.	History of ischemic stroke 6 months prior.	She had a noticeable pulse and a return of spontaneous circulation (ROSC), and the seizure had ended spontaneously [9].	In the ED, adenosine is still a reliable and secure therapeutic option for PSVT [9].
Bailey et al, 2016 [10]	Adenosine	1	Case Report	No complications	Methamphetamines, benzodiazepines, and opioid misuse resulted in dilated, non-ischaemic cardiomyopathy (NICM) with an ejection fraction of 25 to 35% also have a history of	Adenosine was then given in further doses of 24 mg and then 36 mg. A successful, sustained conversion and return to a normal sinus rhythm were	Aware of the adenosine's complications and limitations along with the appropriateness to stray from

					hypertension [10].	induced by the final dose of 36 mg (NSR) [10].	the recommended dosage schedule [10].
Arora et al, 2014 [11]	Adenosine	1	Case report	ST elevation in the inferior leads (Inferior wall MI), Hypotension, and gasping	No previous diagnosis	No abnormality was detected in coronary angiography, Normal ECG, or Normal Echocardiography.	Particularly in patients with a history suggesting vasospastic angina, caution should be used. Following an adenosine injection, a sudden start of chest discomfort should notify the doctor of this unlikely likelihood [11].

Table 2: Complications post adenosine administration. (RCT- Randomized control trial, ECG- Electrocardiogram, GTC- Generalized Tonic-Clonic, ROSC- Return of spontaneous circulation, ED- Emergency department, PSVT- Paroxysmal supra ventricular tachycardia, NICM- Non-ischemic cardiomyopathy, NSR - Normal sinus rhythm)

Author and year of publication	Drug studied	Number of patients	Type of Study	Complications/ Adverse effects
Ahmad et al, 2021 [12]	Adenosine and CCB (Verapamil and Diltiazem)	-	Systematic Review (Pre hospital study)	-Adenosine- • 13 of 17, suffered drug-related adverse effects including flushing, electric shock-like sensations, and chest tightness. • 25 of 87 patients developed SVT recurrence (23 within the hospital and 2 outside the hospital) • 45% recurrence in the "adenosine only" group. -Verapamil- • 3 of 11 patients didn't convert to sinus rhythm (1 of those 3 developed hypotension) • 17 of 52 patients developed SVT recurrence -{(Adenosine/verapamil group)- 28% recurrence with one patient developed reduced systolic blood pressure}
Shokri et al, 2021 [13]	Adenosine and verapamil	268 [134+134]	RCT	-Adenosine- Bradycardia, Dyspnoea, Premature ventricular complexes, dizziness, facial flushing, and vomiting -Verapamil- Hypotension, bradycardia, Dyspnoea, Premature ventricular complexes,

				dizziness, and vomiting
Alabed et al, 2017 [14]	Adenosine and CCA (Calcium channel antagonists)	622	A systematic review (Intervention review)	MAJOR ADVERSE EVENTS: <u>-Adenosine-</u> None <u>-CCA-</u> One episode of *hypotension* (occurred at an infusion of 7.5mg of Verapamil*),* *cardiac arrest (pediatric study- 2 participants,* 1st- an infant with cyanotic heart disease and electrolyte disturbances. 2nd infant was already on beta blockers for wpw syndrome) (verapamil) MINOR ADVERSE EVENTS: Chest tightness-Adenosine> verapamil Flushing- Adenosine>Verapamil Shortness of breath- Adenosine=Verapamil Nausea, headache- Adenosine>Verapamil (non-randomized component)
Smith et al, 2014 [15]	Adenosine and verapamil	1st study-73 [56 (A)+17	Literature review (Pre hospital	1st study-

		(V)] 2nd study-139 [87 (A)+52 (V)]	setting)	ADENOSINE The atrioventricular blockade, Asystole, Ventricular ectopy, Central chest pain, Headache, Flushing, Weakness, and Bronchospasm. VERAPAMIL Ventricular tachycardia, Hypotension, Bigeminy, and Uncontrolled voiding. 2nd study- ADENOSINE Central chest pain, Shortness of breath, Bradycardia, and Ventricular tachycardia VERAPAMIL Ventricular tachycardia (2) Hypotension (1) Ventricular fibrillation (1)*

Table 3: Effectiveness and adverse effects of adenosine & CCB in SVT. (CCB- Calcium Channel Blockers, SVT- Supra ventricular tachycardia, RCT- Randomized control trial, IV- Intravenous, CCA - Calcium Channel Antagonists, WPW- Wolf Parkinson White syndrome)

Table 1 states the articles related to 'Methods of administration' while Table 2 depicts the articles related to 'complications post adenosine administration' with Table 3 states 'effectiveness and adverse effects of adenosine & calcium channel blockers (CCB) in supraventricular tachycardia (SVT) for detailed description and further interpretation of results. The tables used are original and created by the author. The methods of administration of adenosine from the prospects of its ways, the standard methods, which are recommended by the American Health

Association (AHA), and its simplified and alternative methods along with their termination success. Complications such as palpitations, light-headedness, syncope, shortness of breath, flushing, and dizziness were seen while conducting these randomized control trials (RCT). These methods were used in the non-blinded pattern, in patients with stable PSVT (Paroxysmal supraventricular tachycardia). The alternate method included quickly raising the right arm to 90 degrees perpendicular to the horizontal plane for ten seconds while timing it with a stopwatch.[8] In contrast, the standard procedure, which serves as the control group, was specified as intravenous adenosine administered through the right cubital vein or as close to the heart as possible using a T-connector or stopcock.[8] Adenosine will be administered using a Simplified method that combines it with a saline flush while the normal AHA-recommended method of administering adenosine was been used for the control group.[9] The most prevalent co-morbidity was hypertension and the major chief complaint in both therapy groups was palpitations.[8]

The alternative method with ninety degrees arm raise post adenosine administration. 1 Of 15 patients in the alternative method group experienced light-headedness with a termination success of 86.7% when compared to the standard method which was 80%, where 1 of 15 patients experienced palpitations. On the other hand, the simplified “convenient” method with flush combined with adenosine, had a success rate of 85.7% with no complications reported while the standard method patients encountered with shortness of breath, dizziness, and flushing, which signifies the simplified version and the alternate method were better and safe to administer in stable PSVT. Secondary outcomes included chest pain, dyspnea, and cardiac arrest, but none of the patients experienced these issues. The secondary outcomes did not significantly differ across the groups.[8]

After the initial dosage of adenosine, Paroxysmal supraventricular tachycardia (PSVT) is defined by the ECG response as at least a two-fold increase in RR-interval widening or sinus rhythm conversion.[8] Despite extra instructional efforts, the relatively low conversion rate in several studies was attributed to paramedics' inaccurate ECG interpretation.[9] Moreover, in situations of atrial fibrillation, atrial flutter, and ventricular arrhythmia, adenosine was improperly delivered.[9] SVT for at least ten minutes, then sinus rhythm with each p-wave being followed by a QRS complex, sinus rhythm is described as a consistent ECG rhythm in standard lead II that is between 60 and 100 beats per minute.[9]

Comparing the complications attained by the patient post adenosine administration Generalized tonic-clonic seizure (GTC) seizure, absent pulse, palpitations, light-headedness, syncope, Ventricular fibrillation, ST elevated myocardial infarction (STEMI), hypotension, and gasping. A patient with narrow complex tachycardia with a history of ischemic stroke six months prior was treated with IV Adenosine with no complications. Currently, the same patient showed up with an ECG change of narrow complex tachycardia with retrograde conduction of P waves in lead 1 and Avr. Post IV adenosine administration, ECG revealed non-conducted P waves with ventricular escape beats in which the final escape beat triggered the initiation of Ventricular fibrillation which lasted for 8 seconds. On the other hand, a patient with 184 beats /min and regular rhythm on ECG had SVT and had a weakness, hemodynamically stable width history of SVT, one month prior. During that juncture, chemical cardioversion

(Adenosine 6mg < 12mg <12mg) was carried out but was unsuccessful, which was then proceeded by electrical cardioversion. This time additional doses of 24mg and 36mg lead to a return to normal sinus rhythm (24mg <36mg). Before the administration of the 'additional' doses, ECG was analyzed from prior hospitalization during the time of previous 'higher' doses of chemical cardioversion to evaluate the possibility of WPW (Wolff Parkinson White) or any other risks or complications.[10] Another study reveals, a patient with SVT with a rate of 200 beats/min. When an ECG was performed, inferior leads showed ST elevation, which is a consistent marker of inferior wall myocardial infarction.[11] The patient developed hypotension along with gasping. Post adenosine 6mg administration, the was progressive settling of ST elevation within 4-5 minutes, with ST-segment normalization with no Q wave.[11] Initially, the echo revealed, regional wall motion abnormality with post-adenosine administration, it was normalized while angiography had patent coronary arteries.[11] Vasospastic angina has been the predisposing condition leading to ST elevation along with inferior wall abnormality post-adenosine administration.[11] Ventricular tachycardia due to abnormal myocardial scarring contraindicates Adenosine due to the possibility of worsening the arrhythmia and aggravating Ventricular fibrillation while the adenosine-induced ventricular arrhythmia in the structurally normal heart, premature ventricular contractions, and non-sustained ventricular tachycardia which requires no therapeutic intervention.[9]

Shortly after adenosine administration, generalized tonic-clonic seizures, the patient was unresponsive with absent pulse and prognostic ventricular fibrillation. In patients with prior vasospastic angina, Adenosine leads to ST elevation along with a fall in blood pressure and gasping which requires intubation immediately. The 'additional' doses were given to a hypertensive patient with a history of misuse of methamphetamines, benzodiazepines, and opioids leading to Non- Invasive Cardiomyopathy (NICM) with an ejection fraction of 35%.[10] 1 patient from each group (fifteen participants) (Standard and alternative method group) experienced palpitations and light-headedness within one minute respectively while the patient with GTC seizure and Ventricular fibrillation had a Return of spontaneous circulation (ROSC). In patients with vasospastic angina, adenosine administration which has a prognosis of STEMI should be surveilled by chest pain as a symptom post-administration. The symptomatic complications after adenosine administration include dyspnoea, chest pain, flushing, anxiety, transient/persistent bradycardia, asystole, AV block, and severe bronchospasm while the conversion complications such as atrial fibrillation which requires immediate synchronized cardioversion, non-sustained ventricular tachycardia which is rare and resolves spontaneously, ventricular fibrillation which requires immediate defibrillation, 1:1 conduction which is rare and requires immediate synchronized cardioversion.[10]

Effectiveness and adverse effect of adenosine and Calcium channel blocker (CCB) in a study (RCT) with 268 participants in total with 134 in each group where adenosine administration lead to complications such as Bradycardia, Dyspnoea, Premature ventricular complexes, dizziness, facial flushing and vomiting with an efficacy of 95.5% while the verapamil administration was seen with complications such as Hypotension, bradycardia, Dyspnoea, Premature ventricular complexes, dizziness and vomiting with an efficacy of 81 %.[13] Both the drugs faced complications but due to the shorter time of termination, adenosine was efficacious overall, and both drugs

had minimal side effects.[13] In an intervention review, 622 participants were taken into consideration where Adenosine faced no major adverse events while one patient faced hypotension and two infants precipitated cardiac arrest on verapamil administration.[14] The first infant had a history of cyanotic heart disease and electrolyte disturbances while the second infant was already on beta blockers for Wolff- Parkinson- White (WPW) syndrome. Adenosine was more prone to minor adverse events such as chest tightness flushing, nausea, and vomiting while both groups faced shortness of breath.[14] Verapamil need to be used where adenosine is contraindicated in asthmatic patients, stable patients who has a past history of side effects on administration of adenosine, who has history of SVT relapse with adenosine administration and who has ventricular or ectopic beat as it can start new arrhythmic episode, likewise, adenosine need to used when verapamil is contraindicated in cases such as hypotension, poor left ventricular function, already on beta blockers, tachyarrhythmia (Broad complex tachycardia, unstable or highly symptomatic patients.[14] 2 review papers have been used to compare the adenosine and verapamil in a pre- hospital setting, in which adenosine underwent complications such as flushing, electric shock-like sensations, chest tightness, SVT recurrence, Atrio-ventricular blockade, Asystole, Ventricular ectopy, Central chest pain, Headache, Weakness and Bronchospasm, Central chest pain, Shortness of breath, Bradycardia, and Ventricular tachycardia while the verapamil got up with SVT recurrence, unconverted to normal sinus rhythm, Ventricular tachycardia, Hypotension, Bigeminy and Uncontrolled voiding. In the systematic review, overall Adenosine reversal success was more than verapamil while in the considered literature review, one study showed adenosine superior while the other showed verapamil superior. The ECG interpretation and use of pharmacological agents to treat SVT in the pre-hospital setting were the main objectives for paramedical staff which were assigned after adequate training according to the hospital guidelines.

The two comparison studies in the literature review present conflicting findings between adenosine and verapamil.[15] One of the two studies presented Wide complex tachycardia as an ECG finding in both Adenosine (seven patients) and Verapamil (two patients). An RCT was included in the study to get the relationship between weight, height, and the sinus conversion rates where weight and height have been considered as significant predictors for 1st sinus conversion post adenosine (0.09mg/kg) administration wherein, the success group has 61.0 ± 11.5 Kilograms while the failed group had 78.4 ± 17.0 Kilograms.[6] On the other hand, the success group had a height of 161.9 ± 8.1 centimeters while the failed group had a height of 170 ± 8.9 centimeters. Of the participants' the considered majority were women (69 of 124) with a mean age of 49.7 years.[6]

The Adenosine had more space and variety for adverse effects such as palpitations, lightheadedness, syncope, SOB/gasping, flushing, dizziness, hypotension, bradycardia, Premature ventricular complexes, vomiting, chest tightness, chest pain, electric shock-like sensations, SVT recurrence, AV blockade, asystole, ventricular ectopy, ventricular tachycardia, wide complex tachycardia, where gasping/shortness of breath (SOB), flushing, dizziness, bradycardia, nausea & vomiting, and chest tightness has been most common it most of the studies {SOB > Flushing > (Dizziness, bradycardia, nausea & vomiting, chest tightness) > remaining complications}. In contrast, verapamil has comparatively fewer side effects, hypotension, bradycardia, SOB, Premature ventricular complexes, dizziness, vomiting, SVT recurrence, unconverted to normal sinus rhythm, ventricular tachycardia, bigeminy, uncontrolled

voiding, wide complex tachycardia of which hypotension, SOB were most common. Infants faced hypotension and cardiac arrest {Hypotension > SOB > remaining complications}.

The chief complaint in patients with the "standard method (without hand raise)" of administration is palpitation which got continued ad complication post adenosine administration with hypertension as comorbidity. "Simplified method (flush included with adenosine at once)" with a greater success rate with no complications compared to the "standard method (Flush post adenosine administration)" which precipitates SOB and dizziness. "Alternative method (with hand raised)" with greater germination success rate with some light-headedness. Inaccurate ECG interpretation has also led to complications such as SVT recurrence, and unconverted normal sinus rhythm. Ventricular escape beats and non-conducted P waves marker for initiated Ventricular fibrillation. From the perspective of the significant predictors of the normal sinus conversion, the lesser the height along with lesser weight in accordance with BMI had more success over the failed group which is been same for both genders but more inclined towards women as the participants were more inclined towards women as they were more in number comparatively. ECG of previous hospitalization has been seen as a great assistance for predictor for further complications, evaluation, and even management of the patient.

RESULT

There are some direct evaluations, which can be seen in the comparison of the selected studies on detailed analysis through the graphs. The studies presented in the Graphical comparison 1 adenosine has been a greater success when compared with Verapamil (Calcium channel blocker) with a mean success rate of 71.775%, while verapamil got only 1 study with an increased success rate over adenosine with a mean success rate of 62.8%.

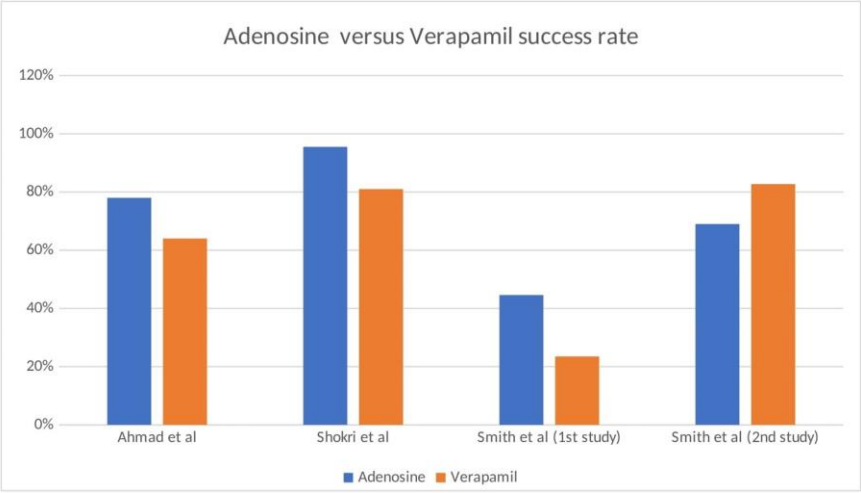

Figure 3: Comparison of Adenosine versus Verapamil success rate.

The statistics of the success rate of methods of adenosine administration (Graphical presentation 2) state that the Alternative and the simplified method, which are not the standardized protocols, were found to be efficient and safe, with lesser complications, even though the difference wasn't very significant. The participants with the simplified method (Adenosine included with flush) had no complications.

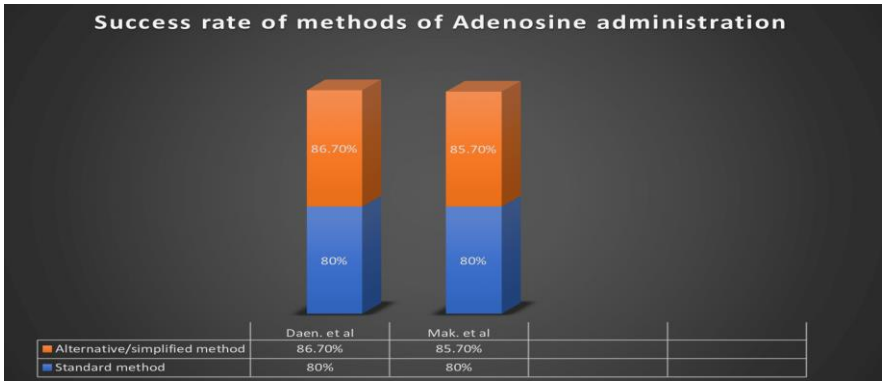

Figure 4: Comparison of the success rate of methods of adenosine administration.

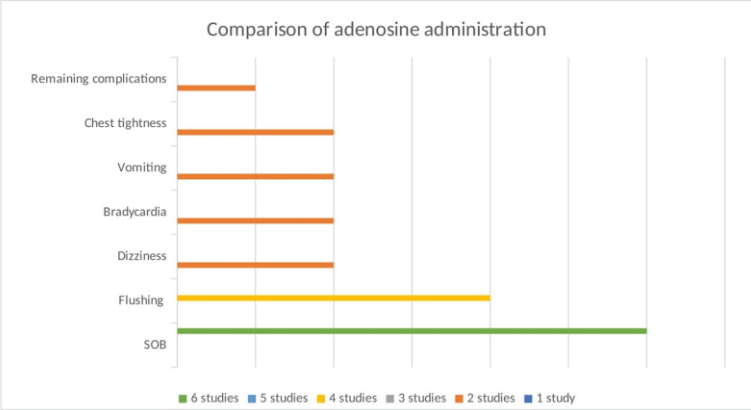

Figure 5: Comparison of complications of adenosine administration in the number of studies that the participants faced.

The detailed analysis of the complications faced by adenosine can be seen represented graphically in Graphical Comparison 3. It deduces that Shortness of breath has been the most affected complication followed by flushing. It follows dizziness, bradycardia, vomiting, chest tightness, and the remaining complications in descending order. On the other hand, complications of verapamil administration reveal Hypotension as the most affected which follows shortness of breath and remaining complications as described in Graphical presentation 4. The graphs used for the interpretation of results are original and created by the author.

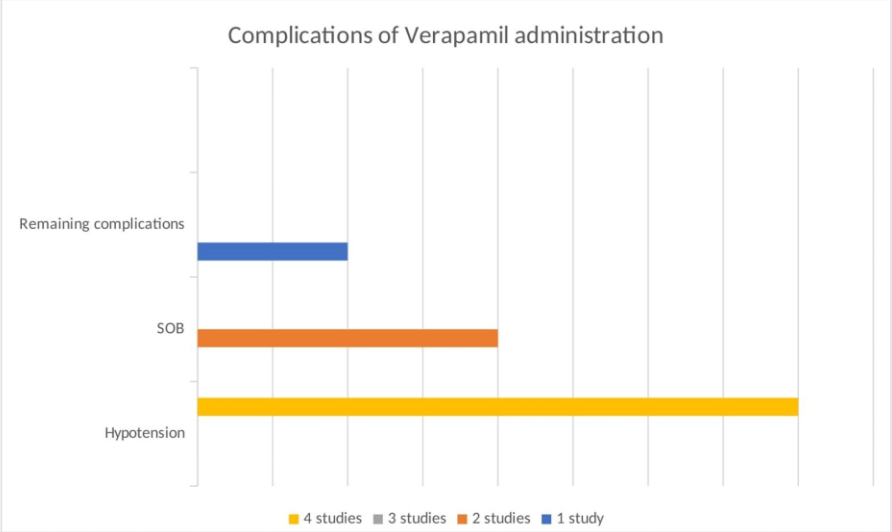

Figure 6: Comparison of complications of Verapamil administration in the number of studies that participants faced.
(SOB- Shortness of breath)

CONCLUSION

In conclusion, the adverse effects and limitations of adenosine when compared to Calcium Channel Blockers (mainly Verapamil) which is used as an alternative in the treatment of narrow complex tachycardia (SVT) and wide complex tachycardia which is seen as a complication post-SVT. Adenosine has been a clear winner, both in terms of side effects and success. Even though Adenosine had greater side effects compared to Verapamil, Adenosine had a greater success rate due to its short half-life and fast conversing action. The paper has been unique in terms of its comparison in terms of comparison of its adverse effects and limitations, methods of administration that modulate the reaction action post-drug administration, and the comparison of the efficacy of the drugs (Adenosine and Verapamil) and their success rate and germination rate.

There are a few limitations of the paper such as the RCTs conducted were involved with stable patients but were nonblinded. There are 3 case reports included which also discuss some rare complications, which are not generally seen in hospitals. The thesis aimed to include all the RCTs but couldn't be possible, as there is not so much primary research conducted in this zone. There are two pre-hospital studies included where the paramedical staff wasn't very much skilled to evaluate through ECG evaluation, which might have led to some of the complications. My suggestion for future researchers is, more primary research is needed on unstable patients, even if it has to be blinded. The doctors and para-medical staff need to be trained for the perfect diagnosis of SVT {Narrow QRS Complex Tachycardia (NCT) and Broad Complex Tachycardia (BCT)}. More researches need to be conducted on the methods of administration and whether it succeeds or needs change in the standardized protocol for drug

administration all over the world for the reduction of complications from the perspective of efficacy and patient safety.

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