

ORIGINAL ARTICLE

EFFICACY OF SLOW INFUSION OF ADENOSINE VERSUS VERAPAMIL IN THE TREATMENT OF SUPRAVENTRICULAR TACHYCARDIA

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Background: Supraventricular tachycardia (SVT) is a critical cardiac emergency necessitating medical intervention. The comparative efficacy and safety profiles of adenosine and verapamil in Pakistani population have not been extensively studied. This study aims to compare the efficacy of slow infusion adenosine versus verapamil in the treatment of SVT in Pakistani patients. **Methods:** A prospective experimental study was conducted involving 100 patients with SVT at a tertiary care hospital in Pakistan. Patients were randomly assigned to receive either a slow infusion of adenosine (n=50, initial dose 6 mg followed by 12 mg if needed) or verapamil (n=50, 1 mg/min up to 20 mg) after the initial Valsalva manoeuvre. The primary outcome was successful termination of SVT. Secondary outcomes included haemodynamic changes and adverse effects. **Results:** The mean age was comparable between groups (adenosine: 52.02±12.19 years, verapamil: 51.98±13.90 years). Verapamil proved superior efficacy with a 100% conversion rate compared to 90% with adenosine ($p=0.02$). Both groups showed similar haemodynamic stability, with no significant differences in post-conversion systolic blood pressure, (verapamil: 123.70±22.35 mmHg vs adenosine: 122.14±15.79 mmHg, $p=0.68$) and diastolic blood pressures. The adenosine group reported higher rates of apprehension (62.9%) and ECG events (63.2%), while both groups showed comparable incidences of other side-effects. **Conclusion:** Verapamil showed higher conversion success compared to adenosine in treating SVT and maintained a favourable safety profile. Verapamil is an effective alternative to adenosine in the management of SVT.

Keywords: Adenosine, Pakistan, Supraventricular tachycardia, Verapamil

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INTRODUCTION

Supraventricular tachycardia (SVT) represents a significant cardiovascular challenge and is characterized by heart rates exceeding 150 beats/min, originating above the ventricles.^{1,2} It affects approximately 2.25 per 1,000 persons of the general population and accounts for significant emergency department visits worldwide.³ In Pakistan, SVT contributes substantially to cardiovascular-related emergency admissions.⁴

The pathophysiology of SVT encompasses several mechanisms, with atrioventricular nodal re-entrant tachycardia (AVNRT) being the most common, followed by atrioventricular re-entrant tachycardia (AVRT) and atrial tachycardia (AT).^{1,5} These arrhythmias can cause significant patient distress, manifesting as palpitations, chest pain, dyspnoea, dizziness, and in severe cases, syncope.^{3,6} The impact on patient's quality of life and healthcare resource utilization necessitates effective and efficient management strategies.

Current guidelines recommend a stepped approach to SVT management, beginning with Valsalva manoeuvre or carotid sinus massage.^{7,8} When these first interventions fail, pharmacological management becomes necessary. Adenosine and verapamil represent two principal pharmacological options, each with distinct mechanisms of action and clinical considerations.

Adenosine acts through rapid blockade of the AV node, while verapamil achieves its effect through calcium channel blockade, resulting in a slower but potentially more sustained response.⁸

While adenosine has traditionally been considered the first-line pharmacological intervention in many healthcare settings^{1,2}, several factors warrant a comparative evaluation with verapamil, particularly in the Pakistani healthcare context. These factors include: cost considerations in a resource-limited setting, availability and accessibility of medications, patient tolerability and acceptance, healthcare provider familiarity and experience, and infrastructure requirements for drug administration and monitoring.^{6,7}

Limited data exists on comparing these medications in the Pakistani population. Genetic, cultural, and environmental factors affect drug responses, requiring local studies. Cost-effectiveness should also be evaluated alongside clinical efficacy.⁸

This study aims to compare the efficacy of slow infusion adenosine and verapamil in the treatment of SVT, and to evaluate the success rate of SVT termination with each drug. Secondary objectives include assessment of haemodynamic stability during and after drug administration, adverse effects, patient tolerability and comfort, and rate of SVT recurrence during the observation period.

METHODOLOGY

This prospective experimental study was conducted at Pakistan Ordnance Factory Hospital, Wah Cantt., Pakistan from 1 Jun 2020 to 25 Aug 2021. The study protocol was approved by the institutional ethics committee Reference Letter No. 4119/HOD ER/Hosp.

Sample size was calculated by using WHO sample size calculator. A total of 100 patients presenting with SVT were enrolled in the study. Patients who are adults (age ≥ 18 years), had electrocardiogram-verified SVT with stable haemodynamics, and gave informed consent were included in the study. Patients who needed rapid cardioversion due to haemodynamic instability, had known hypersensitivity to study drugs, were pregnant or lactation, had history of asthma, significant heart block, and systolic blood pressure (SBP) < 90 mmHg were not excluded.

Patients were randomly assigned in a 1:1 ratio to either the adenosine group (n=50) or the verapamil group (n=50) using computer-generated random numbers. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes. All patients initially received a standardized Valsalva manoeuvre. If SVT persisted, medication was administered according to group allocation. The adenosine group received 6 mg slow IV bolus of adenosine and, if necessary, increased to 12 mg after 2 minutes followed by a quick saline flush. Verapamil group received slow infusion at 1 mg/min with a total dose of up to 20 mg IV, with continuous ECG monitoring.⁹

Demographic data, medical history including previous SVT episodes, vital signs at presentation, continuous ECG monitoring, blood pressure measurements at 5, 10, 15, and 30 minutes post-conversion, and any side-effects were recorded.

Successful termination of SVT, was defined as conversion to normal sinus rhythm. Haemodynamic parameters (blood pressure changes), adverse effects including patient's comfort and tolerability and need for additional interventions were noted.

Data was analyzed on SPSS-23. Continuous variables were presented as Mean \pm SD while categorical variables were presented as frequencies and percentages. Independent *t*-test was used for continuous variables and Chi-square test was used for categorical variables, and $p \leq 0.05$ was considered statistically significant.

RESULTS

The mean age was comparable between groups (verapamil: 51.98 \pm 13.90 years, adenosine: 52.02 \pm 12.19 years, $p=0.98$). Both groups showed similar age distribution across categories (< 41 years, 41–60 years, and > 60 years). The verapamil group comprised 26

(52%) males and 24 (48%) females, while the adenosine group had 20 (40%) males and 30 (60%) females, though this difference was not statistically significant ($p=0.22$). Prior diagnosis of SVT was reported in 32 (53.3%) patients in the verapamil group and 28 (46.7%) in the adenosine group ($p=0.66$).

Baseline clinical parameters were comparable between groups, with no significant differences in SBP (verapamil: 128.82 \pm 22.36 mmHg; adenosine: 127.88 \pm 19.66 mmHg; $p=0.82$), DBP (verapamil: 85.20 \pm 18.76 mmHg; adenosine: 82.76 \pm 13.69 mmHg; $p=0.46$), oxygen saturation (verapamil: 97.70 \pm 1.16%; adenosine: 97.86 \pm 1.78%; $p=0.59$), and initial heart rate (verapamil: 185.14 \pm 17.8 bpm, adenosine: 189.56 \pm 26.23 bpm, $p=0.32$). (Table-1).

Table-1: Pre-treatment patients' characteristics (Independent sample *t*-test) [n (%)]

Patient parameters	Verapamil	Adenosine	<i>p</i>
Age (Mean \pm SD)	51.98 \pm 13.89	52.02 \pm 12.19	0.98
Age n [%]			
<41 Years	11 (52.4)	10 \pm 47.6%	0.92
41–60 Years	25 (48.1)	27 \pm 51.9%	
>60 Years	14 (51.9)	13 \pm 48.1%	
Gender n [%]			
Male	26 (52.0)	20 \pm 40.0%	0.22
Female	24 (48.0)	30 \pm 60.0%	
Past SVT diagnosed			
Yes	32 (53.3)	28 \pm 46.7%	0.66
No	18 (45.0)	22 \pm 55.0%	
Systolic BP (mmHg, Mean \pm SD)	128.82 \pm 22.36	127.88 \pm 19.66	0.82
Diastolic BP (mmHg, Mean \pm SD)	85.20 \pm 18.76	82.76 \pm 13.69	0.46
Oxygen saturation (%)	97.70 \pm 1.16	97.86 \pm 1.78	0.59
HR at start (Beats/min)	185.14 \pm 17.8	189.56 \pm 26.23	0.32

The verapamil group demonstrated significantly higher success rates in SVT termination compared to the adenosine group (100% vs 90%, respectively; $p=0.02$). Both groups showed similar haemodynamic responses post-conversion, with no significant differences in SBP (verapamil: 123.70 \pm 22.35 mmHg, adenosine: 122.14 \pm 15.79 mmHg; $p=0.68$) or DBP (verapamil: 80.88 \pm 13.94 mmHg, adenosine: 78.44 \pm 15.21 mmHg; $p=0.40$) at the time of conversion. (Table-2).

Table-2: Immediate post-treatment vital signs (Independent sample *t*-test, Mean \pm SD)

Drugs Groups	Verapamil	Adenosine	<i>p</i>
Converted with initial treatment	50 (100%)	45 (90%)	0.02
Pre-conversion SBP mmHg	130.42 \pm 23.11	127.44 \pm 19.54	0.48
Pre-conversion DBP (mmHg)	84.12 \pm 21.77	82.34 \pm 12.97	0.62
SBP at conversion (mmHg)	123.70 \pm 22.348	122.14 \pm 15.79	0.68
DBP at conversion (mmHg)	80.88 \pm 13.94	78.44 \pm 15.21	0.40
Heart rate per minute	94.58 \pm 13.83	96.02 \pm 14.30	0.61

Systolic blood pressure measurements were recorded at 5, 10, 15, and 30 minutes post-conversion. Throughout the monitoring period, both groups kept stable haemodynamics with no statistically significant differences. At 5 minutes: SBP (verapamil:

120.94±24.69 mmHg; adenosine: 122.24±14.61 mmHg; $p=0.75$). At 10 minutes: SBP (verapamil: 119.34±17.89 mmHg; adenosine: 119.58±20.08 mmHg; $p=0.95$). At 15 minutes: SBP (verapamil: 119.90±16.50 mmHg; adenosine: 122.00±14.68 mmHg; $p=0.50$). At 30 minutes: SBP (verapamil: 119.46±15.04 mmHg; adenosine: 121.68±13.20 mmHg; $p=0.43$). (Table-3).

Table-3: Mean SBP changes during initial 30 min monitoring after conversion (Mean±SD)

BP measuring intervals	Verapamil	Adenosine	<i>p</i>
5 min	120.94±24.69	122.24±14.61	0.75
10 min	119.34±17.89	119.58±20.08	0.95
15 min	119.90±16.50	122.00±14.68	0.50
30 min	119.46±15.04	121.68±13.20	0.43

Appreciable differences in adverse effects between groups included. Apprehension was more common in the adenosine group (62.9% vs 37.1%, $p=0.05$), ECG events were more frequent in the adenosine group (63.2% vs 36.8%; $p=0.20$). Other side effects including nausea (53.7% vs 46.3%), light-headedness (55.9% vs 44.1%), musculoskeletal pain (52.8% vs 47.2%), chest tightness (55.6% vs 44.4%), dyspnoea (33.3% vs 66.7%), and headache (57.1% vs 42.9%) showed no statistically significant differences between groups. (Table-4).

Table-4: Association of problems with verapamil and adenosine group patients (Chi-square test) [n (%)]

Adverse effects	Verapamil	Adenosine	<i>p</i>
Past SVT diagnosed	32 (53.3)	28 (46.7)	0.41
Nausea	22 (53.7)	19 (46.3)	0.54
Apprehension	13 (37.1)	22 (62.9)	0.05
ECG changes	7 (36.8)	12 (63.2)	0.20
Light headedness	19 (55.9)	15 (44.1)	0.39
Musculoskeletal pain	19 (52.8)	17 (47.2)	0.67
Chest tightness	5 (55.6)	4 (44.4)	0.72
Dyspnoea	1 (33.3)	2 (66.7)	0.55
Headache	8 (57.1)	6 (42.9)	0.56

DISCUSSION

This experimental study, conducted in a tertiary care hospital in Pakistan, demonstrates the comparison between the effects of slow infusion of adenosine versus verapamil in terminating SVT. The 100% conversion rate observed with verapamil, compared to 90% with adenosine, suggests that verapamil may be a superior first-line agent for SVT management in this population.

These findings align with earlier studies that have also reported favourable efficacy with verapamil in certain SVT scenarios. Riaz *et al*¹⁰ found comparable results in their randomized comparative trial, though with some variations in the overall conversion rates. The slower mechanism of action of verapamil, through calcium channel blockade as described by Antman *et al*¹¹ may provide a more sustained effect compared to the rapid but transient AV nodal blockade induced by adenosine.

Our study results are also consistent with Asghar *et al*¹² who reported similar efficacy between adenosine and verapamil in terminating SVT, though our investigation demonstrated superior conversion rates for verapamil. Verapamil selectively blocks calcium channels, prolonging the effective refractory period and slowing conduction through the AV node, thus terminating re-entrant tachycardia as explained by Godfraind¹³.

While adenosine is often recommended as the first-line treatment for SVT due to its rapid onset and short half-life according to ACC/AHA Guidelines (2019), it is also associated with unpleasant side-effects such as chest pain, dyspnoea, and a sense of impending doom, which may contribute to patient apprehension.¹⁴ Gupta *et al*¹⁵ highlighted adenosine's multiple utilities but also acknowledged its significant side-effect profile. In our study, apprehension was significantly more common in the adenosine group (62.9%) compared to the verapamil group. ECG events were also more frequent in the adenosine group, though this difference did not reach statistical significance. These factors may influence patient tolerability and acceptance of adenosine, particularly in a setting where patient comfort is a priority. Feng and Liu's meta-analysis emphasized both the efficacy and safety considerations when selecting adenosine for SVT management.¹⁶

Both groups showed comparable haemodynamic stability, with no significant differences in post-conversion blood pressure measurements. This suggests that both drugs can be safely administered in haemodynamically stable patients with SVT, aligning with findings by Delaney *et al*¹⁷. Lim *et al*⁹ also demonstrated that slow infusion of calcium channel blockers, including verapamil, was as effective as adenosine in treating SVT, with comparable safety profiles. However, continuous ECG and blood pressure monitoring are essential during and after drug administration to detect and manage any potential adverse effects. Marco and Cardinale¹⁸ emphasized the need for vigilant monitoring following adenosine administration due to the risk of transient hypotension and bradycardia.

Shaker H *et al*⁸ further support our findings by demonstrating the efficacy of verapamil in controlling SVT recurrence, suggesting its potential long-term benefits beyond immediate conversion. The higher cost and limited availability of adenosine in some healthcare settings may also favour the use of verapamil as a more practical and cost-effective alternative. The inclusion of verapamil in the WHO Essential Medicines List 2023¹⁹ underscores its global importance as an accessible medication for cardiovascular conditions.

Further research is needed to evaluate the cost-effectiveness of verapamil versus adenosine in the Pakistani healthcare context, particularly considering the

findings of Ahmad *et al*⁷ who emphasized the importance of systematic approaches to SVT management in resource-constrained settings. The availability of generic formulations of verapamil also contributes to its affordability and accessibility in resource-limited settings.

Our findings have important implications for clinical practice in Pakistan and similar settings. Given the higher efficacy, comparable safety, and potential cost-effectiveness of verapamil, it may be considered as a first-line agent for SVT management in haemodynamically stable patients. However, treatment decisions should be individualized based on patient characteristics, preferences, and the availability of resources.⁶

LIMITATIONS

The study was conducted at a single tertiary hospital with a small sample size, limiting generalizability and power to detect minor differences. It focused on stable patients and did not assess long-term outcomes or apply to unstable patients needing urgent cardioversion.

CONCLUSION

Slow infusion of verapamil showed higher conversion success compared to adenosine in treating SVT and supported a favourable safety profile. Verapamil can be an effective alternative to adenosine. Multi-centre large scale study is suggested to elaborate these findings.

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