

COMPARISON OF EFFICACY OF INTRAVENOUS ADENOSINE AND VERAPAMIL IN ACUTE PAROXYSMAL SUPRAVENTRICULAR TACHYCARDIA IN ADULTS

Muhammad Athar,¹ Abdul Majid,² Amir Hussain,¹ Imran Haider,¹ Naveed Shahid,¹ Ijaz Ahmed,¹ Saqib Shafi Sheikh,² Kashif Zafar¹

ABSTRACT

Background: Acute paroxysmal supraventricular tachycardia (PSVT) is a common arrhythmia. If vagal manoeuvres fail, adenosine and verapamil are first line drugs to terminate acute PSVT. Choice of drug depends upon cost, desired onset of action and contraindication. **Objective:** To compare the efficacy of intravenous adenosine and verapamil to convert acute episode of paroxysmal supraventricular tachycardia to sinus rhythm. **Subjects and Methods:** This quasi experimental study was conducted in Emergency Department of Punjab Institute of Cardiology, from 10th July 2006 to 28th February, 2007. This study was conducted on 200 patients of acute PSVT presenting in emergency room and who failed to revert to sinus rhythm with vagal maneuvers. Group A patients received adenosine 6 milligrams (mg) IV bolus. It was followed by 12mg IV bolus, if PSVT not reverted. Group B patients received verapamil 5mg IV, three consecutive doses at 5 minutes interval till PSVT was reverted into sinus rhythm. Time from the administration of drug administration to sinus rhythm restoration was also noted. ECG analysis was done, before and 15 minutes after treatment. Patients in Group A received verapamil in those cases, where PSVT was not reverted with successive boluses of adenosine and vice versa for group B. **Results:** Mean age of patients in group A was 42.8 ± 13.9 years and in group B, it was 40.5 ± 15 years (p value 0.26). There were 58 % males in group A, likewise, 49 % patients in group B were males (P value 0.20). The success rate was 96 % and 95 % for adenosine and verapamil respectively (p value= 0.05). First bolus of adenosine was slightly more effective in terminating PSVT, i.e 74 % in adenosine group and 68 % in verapamil group. Second bolus had almost equal success rate in both groups, i.e. 22 % vs 24% in group A and group B, respectively. The mean time after injection to termination of tachycardia by adenosine was significantly shorter than that of verapamil, 2.1 ± 2.7 minutes vs 5.1 ± 3.5 minutes (p value < 0.0001). **Conclusion:** The overall efficacy of adenosine was similar to that of verapamil, but its onset of action was more rapid. Adenosine in graded doses up to 12 mg, rapidly and effectively terminated acute episodes of paroxysmal supraventricular tachycardia.

Key words: Paroxysmal supraventricular tachycardia, Adenosine, Verapamil, Vagal maneuvers

INTRODUCTION

Paroxysmal supraventricular tachycardia (PSVT) is the most common tachyarrhythmia with a prevalence of 2.25 per 1000 cases, often recurrent and frequent cause of visits to emergency room.¹⁻⁵ PSVT include all tachyarrhythmia's that originate in supraventricular tissue or incorporate supraventricular tissue in re-entrant circuit and has sudden onset and termination.⁶ Atrioventricular nodal re-entrant tachycardia (AVNRT) and atrioventricular re-entrant tachycardia (AVRT) are two major types of PSVT; other rare types are atrial tachycardia, paroxysmal atrial flutter and paroxysmal atrial fibrillation.⁶ The term PSVT is usually related to AVNRT and AVRT.⁷ Re-entrant tachycardia involving the atrioventricular nodal

tissue (AVNRT and AVRT) are characterized by tachycardia with QRS complex of supraventricular in origin, sudden onset and termination generally at rates between 150 and 250 beats per minute with a regular rhythm on electrocardiogram (ECG).⁷ PSVT is characterized by regular R-R interval, QRS of supraventricular origin, heart rate of above 150 beats per minute.⁸ There are some specific features peculiar to different types of PSVT; for example AV nodal reentrant tachycardia shows heart rate of 150-200 bpm; P wave located either within the QRS complex or shortly after the QRS complex.⁹ Similarly AV reentrant tachycardia shows heart rate of 150-250 bpm; narrow QRS complex in orthodromic conduction and wide QRS in antidromic conduction. P wave after QRS complex.^{10,11} Augmentation of vagal tone by manual carotid stimulation and other vagal manoeuvres may restore sinus rhythm. First line drugs for paroxysmal supraventricular tachycardia are adenosine 6 to 12 milligrams (mg) and intravenous verapamil 5 to 15 mg.⁷ Both drugs are effective in terminating PSVT due to AV nodal re-entry in up to 90% of cases.³ Adenosine, a purinergic analogue, transiently blocks AV node, when administered intravenously terminates PSVT

1. Punjab Institute of Cardiology, Lahore, University of Health Sciences, Lahore.

2. Department of Cardiology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan. University of Health Sciences, Lahore.

Correspondence: Dr. Abdul Majid, Assistant Professor of Cardiology, Department of Cardiology, Sheikh Zayed Medical College/Hospital, Rahim Yar Khan.

Email: drmajidjahangir@hotmail.com

Phone: 0323-4187078

involving the AV node as part of re-entrant circuit.⁶ Verapamil is a calcium channel antagonist slows AV conduction and terminates AVNRT.¹²

While both adenosine and verapamil are drugs of choice, adenosine is becoming the preferred agent relative to verapamil because of its rapid onset of action and shorter half life.¹³ Adenosine is highly effective in PSVT characterized by fast rates, whereas the efficacy of verapamil is increased in patients of PSVT with lower rates.¹⁴ The choice between verapamil and adenosine is currently governed by personal experience, preference, cost, contraindication and desired onset of action.^{2,14-16} To compare the efficacy of intravenous adenosine and verapamil to convert acute episode of paroxysmal supraventricular tachycardia to sinus rhythm.

SUBJECTS & METHODS

This quasi experimental study, was conducted at Emergency Department of Punjab Institute of Cardiology, Lahore, from 10th July 2006 to 28th February, 2007. Two hundred patients of acute PSVT age more than 15 years of age were included in the study. One hundred patients were included in Group A and 100 in Group B randomly. Exclusion criteria included PSVT terminated by vagal manoeuvres, history of bronchospasm, wide QRS complex tachycardia (QRS duration more than 120 milliseconds), previous sick sinus syndrome or heart block, heart transplant recipients. History, physical examination, informed consent for drug administration was taken, from patients or his/her attendants. A twelve leads ECG and ECG monitoring were done.

Group A patients received adenosine 6 milligrams (mg) bolus with 20 milliliters saline flush through three way followed by 12mg IV bolus with saline flush if PSVT was not reverted with first bolus.

Group B patients received verapamil 5 mg IV three consecutive boluses at 5 minutes interval, till PSVT was reverted into sinus rhythm. The time was noted from administration of drug to sinus rhythm restoration in both groups. ECG analysis was done by a cardiologist before and 15 minutes after treatment.

Patients in Group A received verapamil in those cases where PSVT was not reverted and vice versa for group B. Data was collected on a proforma and data was entered and analyzed by using SPSS version 10.

RESULTS

In this study, 200 patients with acute PSVT were included and mean age of study population was 41.06 years. Among these 53.5 % were males and 46.5 % were females. Both groups were well matched. There were 58% males in group A, likewise 49% patients in group B were males, (p value 0.20); Mean age of patients in group A was 42.8 ± 13.9 years and in group B was 40.5 ± 15 years (p value 0.26).

Palpitation was the main presenting complaint in majority of patients; 94 % in group A and 100 % in group B. There were associated symptoms like shortness of breath and sinking of heart. Very rarely sinking of heart and vertigo alone was observed. (Table I)

Table I: Baseline characteristics of two groups : A comparison

Variables	Patients characteristics	Adenosine (Group A)	Verapamil (group B)	P value
Age (in years)	15-35	33%	46%	P value = 0.26
	36-55	46%	37%	
	56-75	21%	16%	
	> 76	-	01%	
	Mean	42.8 ± 13.9	40.5 ± 15.1	
Sex	Males	58%	49%	P value = 0.20
	Females	42%	51%	
Clinical presentations	Palpitation and dyspnea	55%	58%	P value insignificant
	Palpitation and sinking of heart	39%	42%	
	Sinking of heart	05%	0%	
	Vertigo	01%	0%	
Mean heart rate before treatment		191.3 bpm	179.5 bpm	
Short RP		75 (91.47%)	73 (85.89%)	
Long RP		07 (8.53%)	12 (14.11%)	
Preexcitation	Absent	99%	96%	P value = 0.17
Preexcitation	Present	01%	04%	

Table II: Outcome after successive bolus doses in both groups

Doses	Group A, (Adenosin) (N=100)	Group B, (verpamil) (N=100)
1 st bolus	74%	68%
2 nd bolus	22%	24%
3 rd bolus	0%	3%
Total	96%	95%

None of our patients experienced syncope. No patient developed hemodynamic compromise. In group A, 96 % had successful reversion with two sequential boluses of adenosine 6 mg and 12 mg. Out of 100 patients, 74 % of patients reverted to sinus rhythm after first adenosine IV (6mg) bolus. Remaining 26% patients required second bolus of adenosine (12 mg) and 22(84.61%) out of these 26, reverted to sinus rhythm with second bolus.

It was also noted that all females in group A reverted with adenosine (either first or second bolus) and four

patients who failed to revert in adenosine group were males. It was observed that success rate to sinus rhythm restoration with first bolus of adenosine was better in females i.e 90.47% as compared to 62.06 % in males (p value < 0.005). Similarly second adenosine bolus resulted in 100 % reversion rate in females and 81.18 % for males. There were four patients, who did not revert with adenosine and when administered verapamil injection, all four patients were reverted to sinus rhythm with verapamil 5 mg IV bolus.

In group B, success rate was 95% with three sequential 5 mg boluses of verapamil. Out of 100 patients, 68 % of patients reverted with first 5 mg bolus verapamil, remaining 32 patients who required second bolus resulted in 24(75%) success rate. Eight patients who were given third bolus, 3(37.5%) reverted to sinus rhythm. Only one female and four males in group B did not revert to sinus rhythm after sequential three boluses of verapamil. When adenosine was administered in these patients, four patients reverted to sinus rhythm immediately. One patient who was known case of Ebstein anomaly and WPW syndrome did not even revert to sequential two boluses of adenosine and he was subsequently given amiodarone IV infusion to which he responded.

Time interval was also noted from the time of administration of drug to achievement of sinus rhythm. Adenosine resulted in rapid achievement of sinus rhythm, mean 2.1 ± 2.7 minutes in group A, as compared to 5.1 ± 3.5 minutes in group B, (p value < 0.001). It was noted that 26 % in group A patients reverted immediately after 6 mg adenosine injection and only 1 % of group B reverted immediately after 5 mg verapamil injection; Which showed rapid action of adenosine as compared to verapamil.

ECG of all patients before and after sinus rhythm restoration was analysed and mean heart rate during tachycardia was 191.3 ± 57.1 in group A, and 179.5 ± 30 in group B.

During tachycardia no clear cut P wave was visible in few patients so RP interval could be calculated in these cases. In remaining cases majority of patients had short RP interval i.e, 91.47 % in group A and 85.89% in group B, rest of the patients had long RP interval. Mean heart rate after sinus rhythm restoration was 93.6 ± 10.8 in group A and $85.3 \pm$ in group B.

DISCUSSION

Acute paroxysmal supraventricular tachycardia (PSVT) attacks can be terminated by different non pharmacological measures. If not terminated, then adenosine or verapamil are administered intravenously to terminate the attacks. Both are first line drugs for treatment in acute PSVT. The choice of drug between adenosine and verapamil depends upon physician choice, cost and desired onset of action. Very rarely patients become hemodynamically compromised and require cardioversion.¹²

In present study, adenosine was compared with verapamil in converting acute episode of PSVT to sinus rhythm in patients who failed to revert with different vagal maneuvers.

Both drugs were found to be equally efficacious in terminating acute PSVT. But adenosine, owing to its rapid onset of action terminated PSVT episode much quicker than verapamil. In this study, adenosine was given in two boluses, first 6 mg and then 12 mg, in contrast to verapamil where three consecutive IV 5mg boluses were given.

In our study, 96 % in group A reverted successfully with two consecutive boluses of adenosine and similar results were with verapamil where 95 % reverted to sinus rhythm. Such observations were consistent with various previous studies, which showed equal efficacy of adenosine and verapamil in terminating PSVT.^{3,17}

Mean age of patients in group A, was 42.8 ± 13.9 years which was very similar to Group B 40.5 ± 15 years. PSVT was considered to be more common in young adults. In our study, probably elder group of patients presented more frequently in emergency for treatment than younger group. Another study, also observed the mean age was 54 ± 17 years in patients of PSVT.¹⁸

We observed, majority of group A patients (74 %) were reverted to sinus rhythm after adenosine 6mg bolus. Davis R et al, observed 65 % success rate with first 6 mg adenosine bolus in acute SVT, which was comparable to success rate in our study.¹⁰ A study had also shown 85% success rate with 6 mg bolus injection.¹⁹

In present study, there were remaining 26 patients who required second bolus of adenosine 12 mg and 84.61% of these 26, reverted to sinus rhythm with second bolus. A study has noted the response in SVT with different doses of adenosine, 3 mg, 6mg, 9mg, 12mg which were given in sequential way and SVT terminated in 35.2 %, 62.3%, 80.2% and 91.4%

respectively.²⁰

Overall 96 % patients reverted with adenosine and four patients who did not revert with even second adenosine bolus, they were administered verapamil 5 mg bolus and all patients responded to verapamil 5 mg bolus. A study has found 81.3 % success rate with verapamil in patients where adenosine did not work.²¹

Although there was slightly better response of adenosine in females than males; 100% and 92 % respectively in our study. In number of previous studies equal response of adenosine was seen in males and females. In group B, three successive 5 mg boluses of verapamil resulted in sinus rhythm restoration in 68 %, 75 % and 37.5 % patients respectively. In total 95 % of the patients in group B, had successful reversion with three sequential 5 mg boluses of verapamil which was almost equal to 96 % success rate with adenosine in group A. Four out of five patients, who did not revert with verapamil, reverted with adenosine.

A study has also compared the efficacy of adenosine and verapamil in acute PSVT. Verapamil administered in 62 patients with successive boluses of 5 mg resulted in 87.1 % success rate in terminating SVT.¹⁷ They noted no difference in efficacy of adenosine and verapamil, 80.6% (52/60) in adenosine group and 87.1% (54/62) in verapamil group. (p value <.0001).¹⁷ Similar results were found in another study by Ballo P et al, (74.4 % vs 81.8 % p value 0.45) between the two drugs.²²

In our study, adenosine resulted in rapid achievement of sinus rhythm. Mean time to sinus rhythm restoration was 2.1 ± 2.7 minutes in group A, as compared to 5.1 ± 3.5 minutes in group B (p value < 0.001). This time difference was due to rapid onset of action of adenosine. Adenosine is rapidly acting drug and resulted in rapid achievement of sinus rhythm restoration, verapamil acts slowly so it took longer time to metabolize and exert its pharmacological action. Here it was also noted that 26 % in group A patients reverted immediately with 6 mg adenosine injection and only 1 % of group B reverted immediately after 5 mg verapamil injection. A study has measured the time; 34.1 ± 19.5 seconds with first bolus of adenosine as compared to (414.4 ± 191.2) seconds (P < 0.0001) with verapamil bolus.

In PSVT rapid heart rate results in palpitation and shortness of breath. In present study, the mean

heart rate before conversion SVT was 191.3 ± 57.1 in group A and 179.5 ± 30 in group B. Mean heart rate after sinus rhythm restoration was 93.6 ± 10.8 in group A and $85.3 \pm$ in group B. A study has noted mean heart rate before termination was 171 ± 21 per minute.²³ Mean heart rate reduction was almost similar in both groups after sinus rhythm restoration, 120 bpm in group A and 105 bpm in group B. Verapamil had slightly more reduction in heart rate as compared to adenosine, possibly because of more prolonged negative chronotropic effect of verapamil than adenosine.²⁴

With care full analysis of retrograde P wave in PSVT on ECG, we observed majority of patients had short RP interval 91.47 % in group A and 85.89% in group B. Short RP means that majority had AVNRT and AVRT as mechanism of PSVT. Porter M J et al also described that AVNRT was the predominant mechanism in acute PSVT (n = 1,042 [56%]), followed by AVRT (n = 500 [27%]) and AT (n = 315 [17%]).²⁵ Although sample selection in this study was done randomly, but small number of PSVT patients, who had already experienced such attacks in past opted adenosine although they were allocated to group B, but number of such patients were very small. Due to this reason there is small risk of selection bias in our study.

Time from administration of drug to sinus rhythm restoration was measured and adenosine reverted sinus rhythm much quicker than verapamil, but some times it was not possible to accurately measure the time in seconds from administration of drug to sinus rhythm achievement in busy emergency room. So we measured the time in minutes and we found that adenosine rapidly converted PSVT to sinus rhythm than verapamil. Issue of cost of adenosine was not addressed in our study.

CONCLUSION

Adenosine in graded doses up to 12 mg rapidly and effectively terminated acute episodes of paroxysmal supraventricular tachycardia. The overall efficacy of adenosine was similar to that of verapamil, but its onset of action was more rapid.

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