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Efficacy of Intravenous Adenosine in Treatment of Paroxysmal Supraventricular Tachycardia in the Local Population

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ABSTRACT

In a prospective study conducted over 4 months at the Accident and Emergency Department, 21 patients with 24 episodes of spontaneous paroxysmal supraventricular tachycardia (PSVT) were treated with intravenous adenosine at incremental doses of 3 mg, 6 mg, 9 mg and 12 mg until termination of the PSVT. There were 6 males and 15 females. The mean age was 54 ± 17 years (range from 23 to 83 years). The mean QRS rate was 171 ± 21 per minute. When data were expressed in a cumulative manner, the response to intravenous adenosine 3 mg, 6 mg, 9 mg and 12 mg in the 24 episodes of PSVT were 5 episodes (21%), 16 episodes (67%), 20 episodes (83%) and 20 episodes (83%) respectively. Adverse effects were present in 10 episodes (42 %) of the PSVT. They were all mild and transient, lasting less than 1 minute.

Keywords: prospective, adenosine, paroxysmal supraventricular tachycardia, adverse effects

INTRODUCTION

Paroxysmal supraventricular tachycardia (PSVT) is a common arrhythmia encountered at the Accident and Emergency Department. Since the 1970s, intravenous verapamil has been the drug of choice[1-3]. However, intravenous verapamil can cause serious side effects. It causes hypotension[4,5] and it can precipitate cardiac failure due to its negative inotropic effect on the heart[6]. It is also not recommended in patients given β-blockers[7] and in patients with Wolff-Parkinson-White syndrome[8-10] as haemodynamic deterioration and collapse may occur with its use in these situations.

In recent years, intravenous adenosine has emerged as the drug of choice for the treatment of PSVT[11]. Adenosine is an endogenous purine nucleotide found in all cells of the body[12]. It exerts its effects in PSVT by slowing conduction through the atrioventricular (AV) node[13]. Its main advantages are its very short half life of less than 10 seconds and the absence of serious side effects associated with its use[11,14,15]. Due to its short half life, adverse effects associated with its use are often transient and short lasting[16].

Adenosine became available in Singapore about 1 to 2 years ago. This study assesses its efficacy in the treatment of PSVT in the local population.

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METHODS

A prospective study was conducted over 4 months from 24 February 1996 to 23 June 1996 at the A & E Department of the National University Hospital, Singapore. Subjects were adult patients who presented to the A & E Department with PSVT.

For the purpose of this study, PSVT is defined as a regular, narrow complex tachycardia with a rate of more than 140 beats per minute and a QRS duration of less than 120 msec. Patients with atrial flutter, atrial fibrillation and sinus tachycardia were excluded.

Patients were excluded if they were less than 16 years of age, pregnant or hypersensitive to adenosine.

Before treatment with adenosine, the clincial history was taken and physical examination performed. A standard 12-lead ECG was done at presentation and after termination of the PSVT. Intravenous access was established at the cubital fossa.

Vagal maneuvers such as carotid sinus massage or Valsalva maneuver were performed initially. If they were not successful, intravenous adenosine 3 mg was then given as a rapid bolus followed by a rapid flush of 10 mL of normal saline. If there was no response in 2 minutes, higher doses of intravenous adenosine were given, followed each time by a flush of 10 mL of normal saline until termination of the PSVT. Intravenous adenosine was given incrementally at bolus doses of 3 mg, 6 mg, 9 mg and 12 mg until termination of the PSVT. If the PSVT was still not terminated after intravenous adenosine 12 mg had been given, intravenous verapamil was then used, unless it was contraindicated (Table I).

If the PSVT recurred after initial termination, the next higher dose of adenosine was given and the protocol continued. The successful dose of adenosine used is defined as the one which resulted in termination of the PSVT without any further recurrence.

Side effects of adenosine and their duration were specifically sought from the patients after treatment with adenosine.

Heart rate, blood pressure and ECG rhythm were monitored continuously during the study.

Table I - Adenosine treatment protocol for PSVT

PSVT
↓
Vagal maneuvers
↓ if unsuccessful
Give i/v adenosine 3 mg
↓ if unsuccessful
Give i/v adenosine 6 mg
↓ if unsuccessful
Give i/v adenosine 9 mg
↓ if unsuccessful
Give i/v adenosine 12 mg
↓ if unsuccessful
Give i/v verapamil (unless contraindicated)

RESULTS

During the 4-month study period, 28 episodes of spontaneous, narrow complex PSVT were seen at the A & E Department. Two episodes converted spontaneously while at the Department. In 2 other episodes, the doctors treating the patients did not follow the study protocol as they were not aware of the study being conducted. Both episodes were treated with intravenous verapamil with successful conversion to sinus rhythm.

The remaining 24 episodes of PSVT in 21 patients did not respond to vagal maneuvers and were treated with intravenous adenosine according to the study protocol. There were 6 males and 15 females. The mean age was 54 ± 17 years (ranged from 23 to 83 years). The mean QRS rate was 171 ± 21 per minute.

During the study period, 1 patient with sinus tachycardia was misdiagnosed as having PSVT and treated with intravenous adenosine. The diagnosis of sinus tachycardia was only made retrospectively. There was no response to the adenosine given and the patient did not suffer any adverse effects. This case was not included in the data analysis.

When data were expressed in a cumulative manner, the response to intravenous adenosine 3 mg, 6 mg, 9 mg and 12 mg in the 24 episodes of PSVT were 5 episodes (21%), 16 episodes (67%), 20 episodes (83%) and 20 episodes (83%) respectively.

Four episodes (17%) of PSVT were not terminated successfully by intravenous adenosine. Three of them were subsequently treated with intravenous verapamil. Two of the 3 episodes of PSVT were terminated by intravenous verapamil. The third episode did not respond despite being given intravenous verapamil 10 mg and after consultation with the cardiologist, was treated with intravenous flecainide 75 mg with successful conversion to sinus rhythm. The fourth episode was a man with chronic renal failure and congestive cardiac failure. Intravenous verapamil was contraindicated in him and after consultation with the cardiologist, he was treated with intravenous amiodarone 300 mg with successful conversion to sinus rhythm.

Ten of the 24 episodes (42%) of PSVT were associated with adverse effects. They were chest discomfort (6 episodes, 25%), dyspnoea (4 episodes, 17%), facial flushing (3 episodes, 13%), palpitations (2 episodes, 8%), giddiness (1 episode, 4%) and generalised burning sensation (1 episode, 4%). All the side-effects were mild and transient and none lasted more than 1 minute. None of them required any active intervention. None of the patients deteriorated haemodynamically after intravenous adenosine was given.

Termination of PSVT with adenosine was associated with transient arrhythmias such as ventricular ectopics, atrial ectopics, sinus bradycardia and sinus pause. However, they were of short duration and none lasted more than 20 seconds.

Three episodes (13%) had recurrence of the PSVT. One converted back to sinus rhythm spontaneously. Another converted to sinus rhythm after a higher dose of adenosine was given. The third case required intravenous verapamil to terminate the PSVT.

Seven episodes of PSVT were considered unstable. Three of them were hypotensive with systolic blood pressure of less than 90mmHg (ranged from 76 mmHg to 89 mmHg). Two had congestive cardiac failure and 2 had angina pectoris. Six of the 7 episodes were treated successfully with intravenous adenosine with termination of the PSVT while 1 episode subsequently required intravenous amiodarone to terminate the PSVT.

One patient had evidence of pre-excitation (Wolff-Parkinson-White syndrome) in his ECG in sinus rhythm. He had converted successfully to sinus rhythm with intravenous adenosine 6 mg.

DISCUSSION

Since the 1970s, intravenous verapamil has been the drug of choice for PSVT in patients who are haemodynamically stable and after vagal maneuvers have failed. In unstable patients (eg. patients with hypotension, chest pain or cardiac failure), synchronised electrical cardioversion is recommended[3].

Intravenous verapamil is recommended because of its efficacy in terminating PSVT. Singh et al[17] in a review of 12 studies, showed that intravenous verapamil was effective in converting 87% of patients with PSVT to sinus rhythm. However, intravenous verapamil can cause serious side effects. It is a strong vasodilator and can cause hypotension. As its half life is several hours, the hypotension may last for a long time. This is especially dangerous if the PSVT is not terminated by it. Verapamil also has a negative inotropic effect on the heart and may precipitate cardiac failure. In patients given β-blockers, intravenous verapamil is also not recommended as the addictive effects of both drugs may result in severe bradycardia and ventricular standstill. Verapamil is also not recommended in patients with Wolff-Parkinson-White syndrome as it may increase the rate of conduction down the

accessory pathway in atrial fibrillation, leading to ventricular fibrillation.

In recent years, intravenous adenosine has emerged as the drug of choice for PSVT. Adenosine became available in Singapore about 1 to 2 years ago.

Adenosine is an endogenous purine nucleotide found in all cells of the body. It has a rapid onset of action and a very short half life of less than 10 seconds. Its short half life is due to the fact that when given intravenously, it is rapidly cleared from the circulation by enzymatic degradation and cellular uptake. Its short half life ensures that any adverse effects, if present, are transient and short lasting. Another attractive feature of adenosine is its relative safety. Unlike verapamil, it rarely causes hypotension and it does not have any significant inotropic effect on the heart. It is also not contraindicated in patients on β-blockers[18] and in patients with Wolff-Parkinson-White syndrome[19]. Adenosine, however, is a weak bronchodilator and caution has been raised in its use in asthmatics[20].

Adenosine exerts its effect in PSVT by slowing conduction through the AV node. The majority of PSVT is due to a re-entrant circuit involving the AV node and when this circuit is blocked, the PSVT is terminated.

Atrial arrhythmias, such as atrial flutter or atrial fibrillation, are often misdiagnosed as PSVT and treated accordingly[15,18]. Intravenous adenosine, however, has been found to be safe when given in these situations. Its transient AV nodal blocking action may even slow the ventricular rate, exposing the atrial activity and allowing the diagnosis to be made. Thus, intravenous adenosine has been recommended for use as a diagnostic agent in narrow complex tachycardia of uncertain cause[21]. In this study, 1 patient with sinus tachycardia was misdiagnosed as having PSVT and treated with intravenous adenosine without any adverse effects.

Another important use of adenosine is in the diagnosis of broad complex tachycardia of uncertain cause[11,21,22]. In this situation, the broad complex tachycardia may be due to ventricular tachycardia (VT) or supraventricular tachycardia with aberrent conduction. Intravenous verapamil is contraindicated in this situation as its haemodynamic effects may lead to cardiovascular collapse if the underlying rhythm is actually VT. Intravenous adenosine, however, has been found to be safe if given in VT and it may even terminate a small percentage of them (VT that is exercise-induced in patients with normal heart)[21,22]. Of course if the broad complex tachycardia is due to supraventricular tachycardia with aberrent condition, it will likely be terminated by the adenosine given.

The technique of administering adenosine is crucial to its efficacy. Due to its short half life, intravenous adenosine should be administered as close to the central circulation as possible[23]. Another point to note is that unlike many other cardiac drugs eg. verapamil or amiodarone, intravenous adenosine should be given as a rapid bolus (instead of slowly), followed by a saline flush to ensure optimal effect. Its rapid onset and short half life also allow it to be given at short intervals of 1 to 2 minutes without fear of toxicity occurring.

A number of studies on adenosine use in PSVT conducted in the electrophysiology laboratory have shown adenosine to be effective in terminating PSVT in up to 100% of cases[13,24-26]. In a study by Cairns and his colleagues[15] on 24 episodes of spontaneous PSVT in the emergency department, intravenous adenosine was found to be 96% effective in converting PSVT to sinus rhythm. However, in their study, 13 of the 23 initial conversions (57%) recurred and all of them required an alternative drug for conversion and maintenance of sinus rhythm. DiMarco and his colleagues[14] in a multi-centre study also showed that intravenous adenosine was effective in terminating 92% of PSVT. However, their study has a recurrence rate of 9% of the PSVT treated with adenosine and it did not mention what happened to the cases which recurred.

In this study, intravenous adenosine 3 mg was successful in terminating 21% of PSVT. When 6 mg of adenosine was given, 67% of the PSVT were terminated and when 9 mg of adenosine was given, 83% of the PSVT were terminated. Administering the 12 mg dose did not result in any further termination of the remaining 4 episodes of PSVT.

Adverse effects of adenosine have been quoted in various studies as ranging from 16% to 76%[14,18,25,27]. In this study, 42% of the PSVT treated with adenosine were associated with side effects. The most common was chest discomfort (25%), followed by dyspnoea (17%), facial flushing (13%), palpitations(8%), giddiness (4%) and generalised burning sensation (4%). However, all the side effects were mild and transient, lasting less than 1 minute. No active intervention was required in any one of them. None of the patients deteriorated haemodynamically after treatment with intravenous adenosine.

Transient arrhythmias are often seen during conversion of PSVT to sinus rhythm after treatment with intravenous adenosine. However, they are usually short-lasting and well tolerated[11,14,18]. This was also the case in this study.

A problem of adenosine use is its relatively high recurrence rate. This is due to its very short half life. Various studies have quoted recurrence rates ranging from 3% to 57%[14,15,18,25,27]. In this study, 3 episodes (13%) of the PSVT had recurrence after treatment with adenosine. One episode subsequently required intravenous verapamil to terminate and maintain it in sinus rhythm.

In this study, 7 episodes of PSVT were considered unstable. Intravenous verapamil would have been contraindicated in their use and synchronised electrical cardioversion would be required. However, electrical cardioversion is unpleasant and patients usually need to be sedated

first. This may further compromise the blood pressure and may also cause respiratory depression. In a number of studies[18,27,28], intravenous adenosine has been used in these situations. Adenosine is especially useful in these situations because of its rapid onset and relative safety. In fact, Garrett et al[16] in a review said that intravenous adenosine should be used in complicated PSVT and that in uncomplicated PSVT, there is little to choose between verapamil and adenosine. In this study, intravenous adenosine was safely given in the 7 episodes of unstable PSVT although 1 episode subsequently required intravenous amiodarone to terminate the PSVT.

CONCLUSION

In summary, this study shows that intravenous adenosine is effective in converting 83% of PSVT to sinus rhythm when used in the local population. Adverse effects, although frequent, are mild and transient. Adenosine is especially useful in situations where the use of verapamil is contraindicated.

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