Impact of a modified Valsalva manoeuvre in the termination of paroxysmal supraventricular tachycardia

S Walker, P Cutting

ABSTRACT

Background Paroxysmal supraventricular tachycardia (SVT) is a relatively common problem presented to the emergency department. Most sources advocate the use of vagal manoeuvres as first-line management, including Valsalva manoeuvre. Despite this, there is lack of standardisation as to how the technique is performed. There is currently no ‘gold standard’ Valsalva manoeuvre. We propose a modified Valsalva manoeuvre, based on techniques described in small-scale electrophysiological studies, but no large clinical trials.

Objective The study was designed to assess the impact of introducing this modified Valsalva manoeuvre as the departmental standard for non-pharmacological reversion of SVT.

Methods A retrospective audit reviewing the preceding 6-month presentations of SVT was performed, and a questionnaire assessing techniques used and anticipated success rates was completed by a representative sample of emergency department doctors. Finally, a prospective trial of the impact of the modified Valsalva manoeuvre on patients presenting in SVT to the emergency department was performed. After meeting the study criteria and giving consent, the patients were instructed to perform the modified Valsalva manoeuvre, that is, while lying supine on the bed in a Trendelenberg position, they forcefully expire into a section of suction tubing and pressure gauge for at least 15 s and at a pressure of at least 40 mm Hg.

Results The retrospective 6-month audit revealed only one successful reversion with Valsalva from a sample of 19 patients. Thirty-two doctors completed the questionnaire describing a variety of different Valsalva techniques highlighting a lack of consensus. 27 patients were recruited to the prospective trial, of whom 19 were correctly diagnosed as having paroxysmal SVT. Of these 19 patients, 6 reverted with the modified Valsalva manoeuvre.

Conclusion Our findings support previous observations that there is lack of standardisation as to how Valsalva is performed, and an apparent reliance on adenosine. The impact of introducing this technique as our departmental standard was a raise in non-pharmacological reversion from 5.3% to 31.7% with no reported significant adverse effects.

Paroxysmal supraventricular tachycardia (SVT) is the most common dysrhythmia in children (1 in 250 to 1 in 1000) and a reasonably common cause for adult presentation to the emergency department.1 2 The term SVT represents a clinical syndrome resulting from a variety of different dysrhythmias—for the purpose of this study, the authors will use SVT as a generic term to describe re-entry tachycardias: atrioventricular nodal re-entry tachycardia and atrioventricular re-entry/reciprocating tachycardia. If the tachycardia involves the atrioventricular node as part of the re-entry circuit, then methods to increase atrioventricular nodal blockade, that is, vagal manoeuvres, may terminate the tachycardia and revert to sinus rhythm.3

Most sources advocate the use of vagal manoeuvres as first-line treatment of cardiovascularly stable patients with paroxysmal SVT.1 3–12 While many variations of technique have been described with variable success, there is, as yet, no standardised, universally accepted ‘gold-standard’ Valsalva manoeuvre used in clinical practice. A recent paper by Smith et al does propose a gold standard Valsalva manoeuvre (40 mm Hg, 15 s, supine position) for use in the prehospital setting based on an electronic database literature review. This conclusion is reached despite noting that few of the cited studies upon which it is based agree on a standardised technique.13

RATIONALE FOR THE MODIFICATION TO THE VALSALVA TECHNIQUE

There is a paucity of Emergency Department studies delineating the most effective Valsalva manoeuvre for patients presenting in SVT. Furthermore, while commonly used resource texts for trainees such as the Oxford Handbook series and Advanced Life Support Group manuals advocate the use of Valsalva, they either give little or no information as to how exactly to perform the manoeuvre.1 4 5 This has two implications: First, as Taylor and Wong observe, doctors frequently incorrectly instruct patients on how to perform the most effective Valsalva manoeuvre.9 Second, as has been commented on in several studies, there is a general underuse of Valsalva and an over-reliance on adenosine, a drug that, despite high reversion rates, has a high side effect profile and cost implications (£4.50 per 6 mg).2 7 9 14 15

In clinical practice, most doctors instruct patients to perform a Valsalva manoeuvre in a sitting or semirecumbent position. In contrast, most research involving Valsalva positions the patient/study participant supine.6 9 11 16–18 The theory behind increased success in a supine position lies in augmenting the patients’ vagal tone and attenuating the sympathetic tone in addition to increased venous return during phase IV of Valsalva.6 9 11 12 16 17 19 20 A summary of research findings can be seen in table 1. If there is a benefit in increasing dependency from sitting to supine, then...
it is plausible that increasing this to a head-down position will further increase reversion success.

This study aimed to analyse the existing management of SVT and corresponding success rate of treatment in a large city-centre teaching hospital prior to the introduction of the modified Valsalva manoeuvre. Having used the technique for several years, the authors believe that it produces a higher reversion rate than any other described vagal manoeuvre in a clinical setting. The study was designed to assess the impact of introducing this modified Valsalva manoeuvre as the departmental standard for non-pharmacological reversion of SVT.

METHODS

In order to adequately establish existing practice and then to assess the impact of introducing the modified Valsalva manoeuvre, several study types were employed:

Retrospective case review

To review existing practice as a baseline for measuring improvements in reversion rates, a retrospective audit of the preceding 6 months’ presentations to the Emergency Department at the Leeds General Infirmary (1 February 2006 to 31 July 2006) was performed. Using the emergency department electronic patient tracking system and reviewing the resuscitation room patient log book, all patients attending with SVT as the presenting complaint were identified. Patient emergency department notes, hospital records and ECGs were analysed. Details of patient gender, age and duration of SVT were sought in addition to documentation of attempted vagal manoeuvres with corresponding success.

Table 1 Summary of research findings on cardiovascular response to patient position

<table>
<thead>
<tr>
<th>Study finding</th>
<th>Author (Reference)</th>
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| A significant reduction (20% vs 54%) in the efficacy of Valsalva at reverting paroxysmal SVT when standing compared with supine in a group of 35 patients with inducible and sustained SVT. Sixty-five healthy subjects in sinus rhythm performing Valsalva in a series of positions studied established a significant increase in mean postmanoeuvre R-R interval (and therefore decrease in heart rate) when supine compared with sitting or semirecumbent. Studied the effects of respiration and posture on 11 patients with known paroxysmal SVT and demonstrated that increasing body dependency to a head-down position alone increased blood pressure sufficiently to revert 8 out of 11 patients (albeit in a highly controlled laboratory environment). Compared baroreflex sensitivity with postural changes in 14 healthy subjects. A significant decrease in heart rate during the fourth phase of Valsalva, a significant increase in cardiac vagal activity and a decrease in sympathetic activation when comparing head-up to a head-down position were observed. Examined the effects of head-down tilt on 17 patients with paroxysmal SVT and concluded that it conferred no additional benefit (Valsalva method used was asking the patients to ‘bear-down’ for 5 s). | Mehta et al6
Wong et al11
Waxman et al12
Kardos et al16
Ornato et al10 |

Cross-sectional study/questionnaire

The authors suspected that there would be inadequate detail in the patient records as to how the Valsalva was performed so a paper-based questionnaire was developed and completed by a cross section of medical staff within the Department of Emergency Medicine (see table 2).

Prospective observational study

Ethical approval was received from the Leeds (West) Research Ethics Committee and the Leeds Teaching Hospitals Research and Development Department. Informed consent was obtained from all patients involved in the study.

The emergency department medical staff received instruction in the new technique via a series of educational sessions conducted by one of the authors (SW). An SVT management proforma was developed, which served both as a management guideline and also a data collection form.

The project occurred between 1 February 2007 and 1 February 2008 during which all patients presenting to the Leeds emergency departments with SVT were considered for inclusion in the study.

On presentation in suspected SVT, patients were moved into the resuscitation room and had routine observations performed in addition to cardiac monitoring. A 12-lead ECG analysis by the attending physician was used to confirm the diagnosis of SVT, after which patients were assessed for exclusion criteria (see table 5).

The modified Valsalva manoeuvre was then performed. With the patient’s cardiac rhythm being continuously monitored, the patient’s trolley was raised to its full height. The head end of the trolley was then fully lowered so that the patient was in a Trendelenberg position (owing to differences in trolleys across the two sites, this would achieve a range of head-down tilt from 10° to 15°). A new 20-cm precut length of suction tubing was attached to a designated aneroid pressure gauge (figure 1), through which the patient was instructed to blow as hard as possible, aiming to generate and sustain a minimum pressure of 40 mm Hg for at least 15 s (figure 2). Following pressure release, the patient was instructed to relax. If the Valsalva was not initially successful, the manoeuvre was repeated up to three times with a 1-min rest between attempts. If Valsalva did not result in reversion, patients received adenosine as per the department’s usual guidelines. In all cases, copies of the prereversion and postreversion ECGs (where applicable) were kept for later review with copies of the emergency department notes and SVT proforma.

Subsequently, these ECGs were examined by a consultant cardiologist to verify emergency department diagnoses. Statistical assistance was provided by the lead medical statistician at Leeds General Infirmary Research and Development Department.

Table 2 Summary of responses to departmental Valsalva questionnaire

<table>
<thead>
<tr>
<th>Summary of responses</th>
<th>Valsalva questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-rated success rate at reversion</td>
<td>20% mean (range 0%—100%) (Mean for Consultant respondents—12%)</td>
</tr>
</tbody>
</table>
| Position for Valsalva manoeuvre | Sitting 14
Sitting forward 1
Semi-recumbent 4
Supine 8
Mixed positions 3 |
| Duration of attempt | Mean—10 s (4 respondents—as long as possible) |
| Adjunct used | Syringe 28
Tubing 1
None (closed mouth) 1 |
Data analysis was undertaken using Statistical Package for the Social Sciences (SPSS V.15, SPSS). Differences in proportions (eg, by sex) were compared using Fisher’s exact test or Chi square test for independence. Comparisons between continuous variables (eg, age) undertaken using a two-tailed t test or exact Mann–Whitney U test. The results are considered statistically significant if p<0.05, CIs are 95%.

RESULTS

Retrospective case review
The initial audit of patients with SVT between February and August 2006 showed 19 cases of SVT that could be confirmed on a 12-lead ECG. Of these 19 cases, there is documentation in the emergency department records of attempted vagal manoeuvres for nine patients with one recorded success. The remaining 18 patients all received adenosine. The mean patient age was 53.7 years and the male to female ratio was approximately 1:4. The median duration of SVT was 2 h. No information was given in any record as to how the Valsalva was performed.

Cross-sectional study/questionnaire
Thirty-two questionnaires were completed by a range of emergency department doctors, reflecting the spectrum of experience in the department (3 Foundation Year 2s, 11 senior house officers, 5 senior house officers, 1 staff grade, 7 specialist registrars, 5 consultants). Of these, 30 had previously used Valsalva manoeuvres. A summary of responses can be seen in table 2.

Prospective observational study
From the prospective arm of the research project over a 1-year period (February 2007–February 2008), 27 patients met the inclusion criteria for the study. On examination of the ECGs, emergency department and hospital notes, six of these patients were subsequently found to be in atrial flutter or fibrillation and another two in atrial tachycardia. Nineteen patients were therefore confirmed to have presented in SVT and were included in further analysis.

Using the modified Valsalva manoeuvre, six of the 19 patients reverted to sinus rhythm 31.7% (CI 10% to 53%, p=0.09) and there were no recorded instances of dysrhythmia reoccurrence. Of the remaining 13 patients, 12 reverted with adenosine (8 with 6 mg, 4 with 12 mg) and 1 patient reverted while vomiting.

Given the small number of patients involved in the study and incomplete data available (in the case of median pressure sustained), restricted statistical analysis was performed in order to determine if there were significant demographic differences between the success and non-success group (see table 4).

DISCUSSION
This study is the first to assess what the authors consider to be an adequately performed Valsalva manoeuvre in a head-down

Table 3 Exclusion criteria for modified Valsalva manoeuvre study

<table>
<thead>
<tr>
<th>Exclusion criteria</th>
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<tbody>
<tr>
<td>Glasgow Coma Score &lt;15/15</td>
</tr>
<tr>
<td>Evidence of new heart failure</td>
</tr>
<tr>
<td>Cardiac-sounding chest pain</td>
</tr>
<tr>
<td>Systolic blood pressure &lt;90 mm Hg</td>
</tr>
<tr>
<td>Inability, through any reason, for the patient (or parent in the case of paediatric cases) to provide informed consent</td>
</tr>
</tbody>
</table>

Table 4 Breakdown of results of modified Valsalva manoeuvre

<table>
<thead>
<tr>
<th></th>
<th>Success with modified Valsalva</th>
<th>No success with modified Valsalva</th>
<th>Significance level (p Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number patients</td>
<td>6</td>
<td>13</td>
<td>Not analysed</td>
</tr>
<tr>
<td>Male/female</td>
<td>4:2</td>
<td>5:8</td>
<td>0.35</td>
</tr>
<tr>
<td>Mean age in years (SD)</td>
<td>42.5 (12.61)</td>
<td>49.7 (17.35)</td>
<td>0.378</td>
</tr>
<tr>
<td>Median duration SVT in hours (IQR)</td>
<td>2.25 (5.5)</td>
<td>2 (5.5)</td>
<td>0.77</td>
</tr>
<tr>
<td>Median pressure sustained in mm Hg (IQR)</td>
<td>60 (30)</td>
<td>30 (40)</td>
<td>Not analysed</td>
</tr>
<tr>
<td>Previous SVT?</td>
<td>4</td>
<td>9</td>
<td>Not analysed</td>
</tr>
<tr>
<td>Previous adenosine?</td>
<td>2</td>
<td>6</td>
<td>Not analysed</td>
</tr>
</tbody>
</table>

Significance level for male/female analysed with Fisher’s exact test. Two-tailed t test used for age and exact Mann–Whitney test for duration.
position on patients in paroxysmal SVT in a clinical environment.

Auditing the existing practice of SVT management in the department prior to the introduction of the modified Valsalva manoeuvre demonstrated only one successful non-pharmacological reversion in a sample of 19 patients. The remaining 18 patients received adenosine, highlighting the reliance on this agent, a fact that has been noted in several other papers.7–9 11 12 16 The fact that written evidence of attempted Valsalva was only found in 9 cases (47%) could either reflect a genuine underuse of the technique or inadequate documentation, the authors suspect the latter is the more likely, as local and national guidelines would recommend the use of Valsalva in the initial management of SVT.4 14 In either case, the vast majority of patients were given adenosine, and the baseline rate for successful reversion with vagal manoeuvres was only 5.5%. From analysis of the questionnaire, we can infer how vagal manoeuvres might have been performed in the initial audit period: it is clear that there was no consensus in patient positioning, length of expiration, pressure produced in expiration or even in the number of attempts made. Crucially, the majority of patients would be expected to perform Valsalva while sitting, avoiding the cardiovascular benefits of a more dependent body position.6 7–9 11 12 16 18 19 21 Furthermore, most patients were asked to expire for 10 s, which is shorter than the 15 s research studies suggest is effective.6 7–9 11 12 16 18 19 21

In our study, the modified Valsalva manoeuvre successfully reverted six out of 19 (31.7%, 95% CI 10% to 55%, p<0.09) patients presenting in SVT with no instances of recurrence within the department. This figure is higher than all comparative (non-laboratory-based) studies reviewed, which report between 0% and 19.4% success rates.2–7 8 10 Despite the lack of statistical significance, we believe this represents a marked increase in non-pharmacological reversion rates for our departments from 5.5% observed in our initial audit. While there are no statistically significant differences in the patient groups who did and did not revert with the modified Valsalva manoeuvre, this may be caused by the small sample size. Bearing this in mind, it may therefore be appropriate to comment on various non-statistically significant trends: First, there appears to be a higher proportion of men in the group who responded to Valsalva (4/6) compared with those who did not (5/13), although this is not statistically significant (p=0.55). Other studies have examined sex-related differences in response to Valsalva with mixed conclusions.6 10 18 19 Interestingly, the male to female ratios of our initial audit group (male/female, approximately 1:4) compared with the research group (male/female, 9:10) shows a higher proportion of females in the former—this does not however meet statistical significance (χ² value with Yates’ correction=1.87, corresponding p=0.17), and we have no explanation for this.

Increasing age has been described in many studies to be associated with decreasing response to Valsalva manoeuvre.6 In our study, the mean age for the group who reverted with the modified Valsalva manoeuvre was lower than the non-reversion group (42.5 vs 49.7 years), although this was not statistically significant (see table 4). It is anticipated that ageing is associated with attenuated autonomic responsiveness.6

Regrettably, the aneroid pressure gauge broke for a period of the study and was not reported to the researchers. This restricts our analysis of effectiveness of performed Valsalva. The intention was to determine whether patients who did not revert were prevented from doing so by a poorly performed Valsalva, but from our data set, this is not possible. We can comment that for those patients reverting with the modified Valsalva manoeuvre when an accurate pressure reading is available, a pressure of greater or equal to 50 mm Hg was achieved and maintained for at least 15 s. Most studies on adults use the standard of 40 mm Hg pressure for an ‘adequate’ Valsalva manoeuvre, but this does not take into consideration patient size or respiratory function.8 9 11 18 19 As our study group potentially included children, for whom we found no literature delineating adequate strain pressures, we felt that a more flexible ‘expire as hard as you can’ approach would be more fitting. Attending clinicians were instructed to ask adult patients to aim for “at least 40 mm Hg” and to record the pressure ultimately sustained on the SVT proforma. Looga reports that systematic studies of Valsalva manoeuvre have shown that phase IV hypertension and bradycardia increase with increasing strain pressures.21

We acknowledge the lack of standardisation of prestrain breath volume that has been discussed as a potential source of performance variability for Valsalva but feel that in a clinical environment, this would be impractical to control.21 Nor have we elected to examine potential effects of concurrent patient medication use given the small scale of the study. The modified Valsalva manoeuvre was generally well tolerated with only one patient requesting to abandon the procedure at the first attempt prior to generating greater than 10 mm Hg pressure. One further patient vomited within 10 min of performing the manoeuvre, although it is difficult to deduce causation. Nevertheless, we can conclude that no significant adverse effects occurred and that it appears to be safe in the small sample we tested. In comparison, adenosine has a relatively high side effect profile such as nausea/vomiting, chest pain, headache, flushing and light-headedness, with studies reporting between 22% adverse events in children and 9%–27% in adults.2 14

LIMITATIONS

The principal limitation for a study of this nature is size. It is therefore difficult to draw statistically significant conclusions from the findings. Furthermore, this study age range was 27–77 years despite plans to recruit children and adolescents in SVT. We cannot therefore conclude how successful the modified Valsalva manoeuvre would be on this patient group. Anecdotally, our colleagues in the department have reported success with the modified Valsalva manoeuvre in children on a number of occasions since the study has finished.

CONCLUSIONS

This study shows that introducing our modified Valsalva manoeuvre as the standard for patients presenting to the emergency department in paroxysmal SVT increased the non-pharmacological reversion rate from 5.5% to 31.7%. Our initial audits confirmed that the majority of patients with SVT received adenosine, which, despite high reversion success, has cost implications and a relatively high side effect profile. We also conclude that, in agreement with other studies, many doctors failed to correctly instruct patients how to perform the most effective Valsalva manoeuvre.

As there is currently no higher reported non-pharmacological reversion rate, we would recommend that that our modified Valsalva manoeuvre (namely, head down tilt, expiration for at least 15 s as hard as possible to achieve a pressure of at least 40 mm Hg repeated up to three times if necessary) be attempted as the first-line treatment for SVT. This appears to be safe, simple and more effective than current practice and, as it can be adapted by patients for use at home, has the potential to reduce presentations to hospital, prevent the need for cannulation and decrease drug costs.
Acknowledgements Many thanks to all the Emergency Department staff at Leeds General Infirmary and St James’ University Hospital for their contribution to this research. Special thanks to Dr Campbell Cowan, Consultant Cardiologist, for his assistance with ECG analysis and Phil McShane, Medical Statistician, for his assistance with the statistical analysis.

Competing interests None.

Ethics approval This study was conducted with the approval of the Leeds (West) Research Ethics Committee.

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REFERENCES
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