An Audit of Central Venous Line Insertion, the use of Ultrasound Guidance and the Incidence of Carotid Artery Puncture

Stephen Anthony Mulvany, Chris McConkey, Stephen Allen

ABSTRACT

Review of the literature suggests a decrease in complication rates when using ultrasound guidance in central venous line (CVL) placement. Carotid artery puncture is the most common complication of attempted internal jugular vein catheterisation with an incidence of 2 to 8%. This audit reviewed our local practice in CVL insertion techniques and carotid artery puncture rates for the period May 2008 to May 2009. The findings were reported and a repeat audit was performed for the period of February 2010 to February 2011. The results were interesting.

Keywords: Anaesthesia, Ultrasound, Central venous access.


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Conflict of interest: None declared

INTRODUCTION

The National Institute for Clinical Excellence (NICE) recommends the use of ultrasound guidance for central venous line (CVL) insertion. Review of the literature suggests a decrease in complication rates using ultrasound guidance. Carotid artery puncture is the most common complication of attempted internal jugular vein catheterization with an incidence of 2 to 8%. Airway obstruction, pseudoaneurysm, arteriovenous formation and retrograde aortic dissection have all been reported as a consequence of carotid artery puncture and, in the presence of atheromatous carotid disease, puncture may carry the risk of cerebrovascular accident. NICE however recognise, that the degree to which ultrasound guidance is used may vary according to the clinical situation and the previous experience of the operator.

This Audit reviewed our local practice in CVL insertion techniques and carotid artery puncture rates for the period May 2008 to May 2009. The findings were reported and a repeat audit was performed for the period February 2010 to February 2011. The results were interesting.

METHODOLOGY

All patients having CVL inserted for cardiac surgery have a ‘checklist for CVL insertion’ completed. We retrospectively reviewed all ‘checklist’ forms completed in a 1 year period in the Cardiac Surgery Intensive Care Unit (May 2008-May 2009) (613 patients). The findings were presented at a local and an international meeting. We repeated the process by again reviewing completed forms over another 1 year period (Feb 2010-Feb 2011) to see if any changes in practice had occurred (672 patients). On both occasions, we analysed the frequency of ultrasound use in comparison to traditional landmark techniques. We looked at the complication rates of each technique and the level of experience of those performing the techniques.

Results

In the first study period 40% of CVLs were inserted using ultrasound guidance, the details are shown in the Table 1.

CONCLUSION

For the original data collection period CVL insertion had an overall carotid puncture rate of 6%. Ultrasound guidance was used in 40% of cases, but in these cases there was a significantly higher carotid artery puncture rate. A higher incidence of arterial puncture occurred particularly when using dynamic one person ultrasound guidance (15%).

Results

In the second study period 30% of CVLs overall were inserted using ultrasound guidance, the details are shown in the Table 2.
DISCUSSION

Despite NICE guidance, in this regional unit only 40% of CVLs over the original audit period and 30% of CVLs in the repeat audit were inserted using ultrasound. Despite this, the incidence of carotid artery puncture in the landmark group was in line with the published literature.\textsuperscript{3,4} It is interesting that for the original audit period, dynamic ultrasound was associated with a higher incidence of complications (15%) which would conflict with some of the literature.\textsuperscript{2,3} The reason for this unexpected finding may have possibly been a bias toward ultrasound guidance in patients with more challenging anatomy or it’s use as a rescue technique. Alternatively, it may have suggested that there was a problem with training registrars and consultants in the effective use of ultrasound guidance during CVL insertion. Certainly, there is a recognised learning curve in the technique.\textsuperscript{5} This training issue was highlighted as a direct result of the original audit, and an ultrasound-guided vascular access course was run for trainees in the region. Maybe as a result of this extra training or because of raised awareness in the correct use of ultrasound, the complication rate when using dynamic one person ultrasound fell markedly. We feel that the results reveal another interesting finding which is more to do with the grade of anaesthetist performing the technique. For the original audit period, the complication rate for dynamic one person ultrasound was contributed to by a small frequency of consultants performing the technique and having a proportionately high number of complications. Again, in the reaudit, consultants using dynamic ultrasound are making a greater contribution to the complication rate. When static ultrasound was used, the complication rate was low (5%) originally and fell to zero for the reaudit period, albeit the total numbers for this technique fell also.

It is seen over both study periods, that dynamic ultrasound is used more frequently by trainees. It is a well established practice in this unit that consultant anaesthetists are extremely familiar and competent in the use of the landmark technique for internal jugular venous access. It is for this reason that we feel their complication rates are consistently low with this technique. It was suggested in the original audit that there may be an issue when consultants familiar with one technique attempt to adopt another. This has meant a general shift back to the use of the landmark method. Another observation is that the landmark method would have had an even lower complication rate for the second period, whereas it is not for the contribution made to arterial puncture by the trainees. This may again suggest a learning curve for those trainees coming to this unit and attempting a landmark technique, which although extremely familiar to the consultants, is unchartered territory to the trainee. We would like to suggest that for each technique there is a steep learning curve which needs to be overcome. It is clear that trainees are more used to inserting CVLs under ultrasound guidance and have a low complication rate. It is also clear that consultants in the unit are much more familiar with the landmark technique and correspondingly have a very low complication rate with this technique.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Frequency of use</th>
<th>Grade of anaesthetist</th>
<th>Carotid artery punctures</th>
<th>Carotid artery puncture rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landmark</td>
<td>365 (60%)</td>
<td>Consultant 202 (55%)</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Static ultrasound</td>
<td>159</td>
<td>Consultant 163 (45%)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dynamic one person</td>
<td>71</td>
<td>Consultant 19 (27%)</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Dynamic two person</td>
<td>18</td>
<td>Consultant and Registrar 18 (100%)</td>
<td>3</td>
<td>17</td>
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</table>

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<tr>
<th>Technique</th>
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</thead>
<tbody>
<tr>
<td>Landmark</td>
<td>469 (70%)</td>
<td>Consultant 263 (50%)</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Static ultrasound</td>
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<td>Consultant 233 (50%)</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic one person</td>
<td>152</td>
<td>Consultant 27 (55%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic two person</td>
<td>2</td>
<td>Consultant and Registrar 2 (100%)</td>
<td>3</td>
<td>0</td>
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</table>
This unit encourages the use of ultrasound to aid internal jugular venous line placement in those skilled and well practiced in the technique. This is in line with current NICE guidelines. It does however, recognise that carotid artery puncture can still occur when it is not used correctly. This can be due to failure to keep the tip of the needle visualised with ultrasound as it passes through the vein to puncture the carotid artery. Another pitfall in its use is when excessive compression of the vein occurs with the ultrasound probe making carotid puncture more likely.

REFERENCES


ABOUT THE AUTHORS

Stephen Anthony Mulvany (Corresponding Author)
Department of Cardiac Surgery, Royal Victoria Hospital, Co Antrim United Kingdom, e-mail: stephenmulvany@hotmail.com

Chris McConkey
Consultant, Department of Cardiac Surgery, Royal Victoria Hospital Co Antrim, United Kingdom

Stephen Allen
Consultant, Department of Cardiac Surgery, Royal Victoria Hospital N Ireland, United Kingdom