Correlating IVC Measurements with Intravascular Volume Changes at Three Distinct Measurement Sites

Kimberly Yang BA, BS, University of Arizona, Teresa Wu MD, FACEP, Maricopa Medical Center

Abstract

Bedside ultrasound of the inferior vena cava (IVC) has grown to be an important tool in the assessment and management of critically ill patients. This study endeavors to examine which location along the IVC is most highly correlated with changes in intravascular volume status. We compared the following three sites: (1) the diaphragmatic juncture (DJ), (2) two centimeters distal to the hepatic vein inlet (2HVJ), and (3) at the left renal vein juncture (LRVJ).

Data was collected in this prospective observational study on patients in the adult emergency department who were treated with intravenous fluids (IVF). IVC measurements were recorded at each site during standard inspiratory and expiratory cycles, and again with the patient actively sniffing using rapid forced inspiration. IVF was then administered and the same six measurements were repeated after completion of fluid bolus. The difference in caval index (dCI) was calculated for all six data sets and correlated with the mL/kg of IVF administered.

There was a statistically significant correlation between mL/kg of IVFs administered and dCI at all three sites (DJ: r = 0.354, p=0.0002; 2HVJ: r = 0.334, p=0.0003; LRVJ: r = 0.192, p=0.03). The greatest correlation between amount of fluids administered and dCI was observed at the diaphragmatic juncture. Our data suggests that every mL/kg of IVF administered should change the dCI by 0.86-1.00%. This anticipated change in IVC diameter can be used to gauge a patient’s response to intravascular volume resuscitation.

Results

A total of 117 patients were recruited for enrollment in the study based on the inclusion and exclusion criteria. All six measurements were successfully obtained in 100 of the 117 enrolled patients.

Figure 3. dIVC vs. mL/kg at the Diaphragmatic Juncture (DJ).

Table 2: Mean difference in IVC collapse (dCI) at each site and its correlation to intravenous fluid (IVF) administered (mL/kg). The greatest correlation between mL/kg of fluid administered and change in caval index was seen at the diaphragmatic juncture.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean difference in IVC collapse (dCI) in cm</th>
<th>Correlation between mL/kg of IVF and dCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJ</td>
<td>0.97</td>
<td>0.354</td>
</tr>
<tr>
<td>2HVJ</td>
<td>1.15</td>
<td>0.334</td>
</tr>
<tr>
<td>LRVJ</td>
<td>0.8</td>
<td>0.192</td>
</tr>
</tbody>
</table>

Discussion and Conclusions

Our study demonstrated that the greatest correlation between the amount of intravenous fluids administered and the dCI was seen at the diaphragmatic juncture (DJ) and that this site is where the largest change in diameter can be appreciated on ultrasound during intravascular volume resuscitation. Our data also suggests that for every mL/kg of IVFs administered, the dCI should change in a predictable way, increasing by 0.86-1.00%. This anticipated change in IVC diameter can be used to gauge a patient’s response to intravascular volume resuscitation.

Acknowledgements

I owe everything to my mentor, Dr. Teresa Wu and her guidance and friendship over the years.

Special thanks also to: Daniel Haase, MD Shannon K. Gust, MD Kain-Ning Khor, BS, MPH David Drachman, PhD