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Research article

# Internal jugular vein distensibility in assessment of fluid responsiveness in donors of living donor liver transplantation

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ABSTRACT

*Background:* The concept of brain death is still not acceptable nor implemented in Egypt. Donor safety in liver transplantation is on the top of our priorities.

*Purpose:* The purpose of this study is to evaluate the effectiveness of using IJV distensibility as a reliable method for intraoperative assessment of fluid responsiveness.

*Methods:* A prospective observational study was conducted in Ain Shams university specialized hospitals. 40 donor candidates for right lobe hepatectomy for living donor liver transplantation were enrolled. During period of hypovolemia (T0) left IJV scanned and measured. After a given fluid bolus in the form of ringer acetate 5 ml/kg. ultrasonic and hemodynamic measurements were reassessed 10 min (T 10) after the fluid resuscitation.

*Results:* Highly significant changes in MABP, HR, and CVP ($p < 0.01$) were detected after fluid resuscitation, regarding the IJV distensibility it showed a highly significant reduction from baseline (T0) to post-resuscitation expansion ($P = 0.0001$). Baseline (T0) measurements showed no significant correlation between IJV distensibility and hemodynamic parameters ($P \geq 0.05$). Post-resuscitation values (T10) showed no significance correlation between HR and IJV distensibility ($P = 0.772$). On the other side it showed a highly significance negative correlation between MABP, CVP and IJV distensibility ($r = -0.390$, $P = 0.013$) and ($r = -0.332^{*}$, $p = 0.036$) respectively. The correlation between the percentages of change of IJV distensibility and hemodynamic parameters showed highly significant negative correlation between IJV distensibility and MABP ($r = -0.359$, $P = 0.023$) also with CVP ($r = -0.464$, $P = 0.017$). No difference was found regarding the HR ($P = 0.336$).

*Conclusion:* Organ transplantation centers with experience, CVP monitoring may not be necessary in highly selective patient population. IJV distensibility, a non-invasive and safe method can be used to guide fluid replacement in healthy donor.

## 1. Introduction

The concept of brain death is still not acceptable nor implemented in Egypt, although the Egyptian authorities had adopted a law for organ donation from deceased patient's in 2010, leading to severe shortage of adult organs. The total number of Living donor liver transplant (LDLT) till September 2016 are 2600 cases, preparation for LDLT program in Ain Shams University Specialized Hospital (ASUSH) started since 2001, our first case has been done in 2003. The total number of transplants performed is **283** by December 2016, and expected to increase.

Liver transplant is performed mainly for end-stage liver failure arising mainly from chronic liver disease due to hepatitis C virus inoculation.

Egypt has a very high prevalence of HCV and a high morbidity and mortality from chronic liver disease, cirrhosis, and hepatocellular carcinoma. Approximately 20% of Egyptian blood donors are anti-HCV positive. Egypt has higher rates of HCV than neighboring countries as well as other countries in the world with comparable socioeconomic conditions and hygienic standards for invasive medical, dental, or paramedical procedures [1].

Donor safety is on the top of our priorities as a team and it is widely recognized intraopertively during hepatectomy, there are several potential risks during the Perioperative period of this procedure, numerous studies reported their complications [2–7]. Major and minor complications, with associated rates of occurrences are illustrated in Table 1.

Generally, hepatectomy causes a major bleeding and high need of blood products requirement, which is one of the leading causes of post-

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**Table 1**
Postoperative donor complications by clavien grade [37,38].

| Grade | Complication | N[a] | Rate[b] (%) |
|---|---|---|---|
| 1 | Atelectasis | 16 | 3.70 |
| | Ileus | 15 | 3.46 |
| | Fever | 14 | 3.23 |
| | Pleural effusion | 11 | 2.54 |
| | Hematemesis | 1 | 0.23 |
| | Intestinal obstruction | 1 | 0.23 |
| 2 | Need for blood transfusion[c] | 14 | 3.23 |
| | Pneumonia | 7 | 1.62 |
| | UTI | 6 | 1.39 |
| | Cellulitis | 4 | 0.92 |
| | Bacteremia | 2 | 0.46 |
| | C. difficile colitis | 1 | 0.23 |
| | Wound infection | 1 | 0.23 |
| 3 | Pneumothorax | 2 | 0.46 |
| | Intraoperative vessel injury | 2 | 0.46 |
| | Brachial plexus injury | 1 | 0.23 |
| 4 | Acute respiratory failure | 3 | 0.69 |
| | Cardiac arrest | 2 | 0.46 |
| 5 | Death | 1 | 0.23 |

UTI = urinary tract infection.
[a] Patients can have multiple complications.
[b] Percent of total, N = 433.
[c] Nonautologous, nonintraoperative.

operative complications [8–10]. After several discussions with our surgical team we came to a conclusion that intraoperative fluid management aids to the reduction of the intraoperative bleeding during the procedure, adequate and guided fluid management is considered one of the important strategies to reduce the blood loss besides of the other anesthetic techniques like hemodilution, normovolemia [11], cell salvage usage [12], high Stroke volume variation (SVV) method [13], and low CVP technique [14], the last method is considered the most applicable, simpler, and cost effective technique which could be easier to be performed.

The first prospective report by Jones et al. [15] stated that maintaining a low CVP is a widely used method to minimize intraoperative blood loss [16,17], CVP is believed to reflect the hepatic sinusoid pressure, rendering it an effective indicator for reducing hepatic parenchymal congestion, thus reducing blood loss and controlling hepatic venous hemorrhage [18], it is well known that a target CVP during hepatic resection is 5 mmHg or lower has shown significant reduction of bleeding, morbidity and mortality [16–18].

However several studies have stated that CVP did not correlate with bleeding during the hepatectomy [19–21], Besides, there are potential fatal risks of low CVP strategies during hepatectomy include air embolism and tissue hypoperfusion [22], it was also reported by Jones et al. [15] that a small air embolism was noticed in two patients (5% of patients with low CVP), Another important issue should be taken into consideration; the complication of central venous catheterization is from 5% to 26% in all patients required treatment and monitoring [23].

Therefore, it took us to a new suggestion that a low CVP methods during hepatectomy may not be of a great benefit to the donors, we need more useful, safer and simpler methods for assessment of fluid management in order to reduce blood loss and subsequent morbidities during LDLT.

Point of care ultrasound imaging method of the IJV has been implemented for the evaluation of the CVP [24,25]. Lipton [25] identified the pulsation of IJV using the ultrasound pattern to estimate the CVP.

In this study, we evaluated donors candidates for hepatectomy in Living donor liver transplantation, we hypothesize that point of care ultrasound imaging of the IJV dispensability, would be correlated with the fluid status of the patients. The created database will help in establishing conclusion and recommendations that will help to improve the anesthetic plan, intraoperative management, and increase the donors' safety.

## 2. Methodology

This prospective blinded observational study was performed after obtaining approval from the ethical committee of the Ain Shams University from research ethical committee FWA 000017585, FMASU 313/2015, and registered in Clinical trials.gov; NCT03391037. Sample of 40 donors candidate for right lobe hepatectomy for living donor liver transplantation (LDLT) were included and written informed consent was taken, our main aim during preoperative preparation was to rule out any comorbidities or contraindications to donation by careful history taking, examination and investigations.

General anesthesia was induced in a standard technique with Fentanyl 2–4 µg/kg, Propofol 2 mg/kg and Rocuronium 0.6 mg/kg. Two large-bore peripheral and a right internal jugular central venous catheter were placed. Anesthesia was maintained with a balanced anesthetic technique, consisting of a volatile agent (Sevoflurane 0.7–1 MAC) and a mixture of air and oxygen (FiO2 0.4). For intraoperative analgesia, fentanyl infusion 1–2 µg/kg/h were used and fluids 3–5 ml/kg/h. Anesthetic management included the use of two forced air warming blankets for upper and lower extremities and an infusion blood warmer.

Intraoperative monitoring included ECG, invasive arterial blood pressure (left radial artery), noninvasive blood pressure, continuous central venous pressure (CVP), body temperature, oxygen saturation (SaO2), capnometry (EtCO2) and urine output (mL).

Recruitment of the patients (donors) depends on the presenting signs that led the anesthesiologist to decide if the patient's volume status was hypovolemic and in need for fluid replacement. This diagnostic criteria for volume assessment is usually a combination of heart rate (HR) more than 100b/min, mean arterial blood pressure (MABP) less than 50 mmHg, central venous pressure (CVP) less than 1 mmHg, and urine output hourly (UOP) less than 50 ml/h. During period of hypovolemia, all enrolled patients had left IJV scanned (T0) and measured by one anesthesiologist experienced in point-of-care ultrasound. This point-of-care anesthesiologist is not involved in the anesthetic management of the patient and blinded to the volume status of the patient values. Hypovolemic patients were given a fluid bolus in the form of ringer acetate 5 ml/kg. Ultrasonic and hemodynamic measurements are reassessed 10 min (T 10) after the fluid resuscitation.

Inclusion criteria included age of 20 years or older, candidate for donor right lobe hepatectomy for LDLT and volume assessment diagnosed as hypovolemia intraopertively by the anesthesiologist. Exclusion criteria were inability to scan IJV secondary to surgical dressing, hematoma formation after trial or placement of CVP catheter on left side, or inability for proper positioning. The IJV with a central venous catheter was not examined rather the opposite side was evaluated if no contraindications. No patients were excluded once enrolled and measurements were completed.

Ultrasound measurements were done using a linear transducer probe 6–13 MHz of the SONOSITE M-TURBO (USA). The IJV was measured using the B mode and the M mode.

The measurement technique

1. 30° head elevation.
2. Rotation of head slightly to right side to expose left IJV.
3. Place of linear probe horizontally across the neck and lateral to cricoid cartilage.
4. Applying minimal pressure to obtain adequate image.
5. Discrimination between 2 vessels by compressibility and color flow.
6. M mode to determine maximal and minimal diameter during a respiratory cycle (Figs. 1 and 2).
7. The IJV distensibility index was calculated as IJV maximal AP diameter during inspiration minus IJV minimal AP diameter during expiration divided by the minimal AP diameter during expiration.