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Incidence of Internal Jugular Vein Valve Incompetence through High versus Low Approach for IJV Cannulation

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Abstract

Studies done on internal jugular venous valve (IJVV) competence shows that structural and functional integrity of the IJV valve may be compromised when the IJV is cannulated for insertion of a central venous catheter. USG guided IJV cannulation distal and proximal from anatomical location of IJVV was carried out to study the incidence of IJVV incompetence. *Methods:* Sixty patients undergoing elective major surgery, without pre-existing incompetence of IJV valve were randomly divided in two groups high (distal) and low (proximal) to undergo IJV catheterisation (>1 cm above or below the cricoid level, respectively) under USG guidance. USG confirmation of IJVV status both, anatomical and physiological in normal respiration and with Valsalva manoeuvre was done. Color Doppler ultrasound was used to study the incidence of valvular incompetence at different intervals i.e. at (T1) preoperative, (T2) one week after catheter insertion and (T3) one month after catheter removal, both, during normal respiration and during Valsalva manoeuvres and were compared with baseline T1. *Results:* Incidence of IJVVI, with catheter in IJV (T2) was higher with lower approach than with higher approach (30% vs. 20%; $p < 0.01$) and tended to be so after removal of the catheter (T3) (20% vs. 13%; $p = 0.04$). With Valsalva Manoeuvre, IJV diameter was significantly high in lower group at (T2), with catheter in IJV (H/L) (1.9+0.7/2.3+0.7*) and at (T3), after catheter removal (H/L) (1.9+0.8/2.3+0.9*). $p < 0.001$. *Conclusions:* Cannulation and catheterization of the IJV may cause long lasting functional impairment of the IJV valve. IJV cannulation above the level of cricoid cartilage, under USG guidance helps to some extent in lowering the incidence of IJV valve incompetence.

Keywords: Central venous catheter; IJVV; Color Doppler; Complication; Intracerebral venous pressure.

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Introduction

Existence of IJV valve was described by Harvey [1]. In approximately 90% of human internal jugular veins (IJVs) there is a valve [2,3]. It is situated directly above the termination of the IJV in the inferior bulb, the position of which may vary slightly from being almost directly posterior to the head of the clavicle to a position 3 cm further inferior and 3 cm further lateral [4]. Clinical significance and implication of the IJV valve competence is the fact that prevents backward blood flow toward the brain when the intrathoracic pressure acutely increases and can create trans valvular gradients of up to 100 mmHg [4,16]. The competence of the valve has been found to be crucial for developing a trans cranial blood pressure gradient during cardiopulmonary resuscitation with closed-chest compression [5]. In addition, this valve prevents sudden increases in the IJV pressure

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during coughing or positive pressure ventilation and may thus protect the brain from acute increases in intrathoracic pressure [4,6].

Imai et al. reported in a preclinical study that competent IJV valves became incompetent after being intentionally punctured with a 14-gauge needle. Because the IJV valve may be situated slightly above the clavicle at the base of the neck, they raised the concern that it may be injured in clinical situations when the IJV is cannulated at the lower neck for insertion of a central venous catheter [4,6]. To decrease the risk of direct puncture of the proximally located valve, they recommended using a more distal site for cannulation of the IJV, at the level of thyroid cartilage [6].

The question this study addressed was whether a high approach to internal jugular vein puncture reduced the incidence of internal jugular vein valve damage [6]. We planned the study under guidance of Doppler ultrasound to evaluate the incidence of IJVV incompetence with two different approach of cannulation and catheterization of the IJV in patients undergoing planned major surgeries [8].

Material and Methods

Institutional approval and patients' written informed consent were taken before study. Sixty patients of ASA I and II, planned for elective major oncosurgical procedures (Ivor-Lewis operation, Whipple's surgery, Three stage oesophagectomy) were taken for the study. Patients were divided in two groups equally. USG confirmation of IJV valve status both, anatomical and physiological in normal respiration and with Valsalva manoeuvre was done. Patients without pre-existing incompetence of IJV valvewere randomly divided in two groups high (distal) and low (proximal) to undergo right IJV catheterisation (> 1 cm above or below the cricoid level respectively), under USG guidance.IJV was cannulated with an 18-gauge needle, and the Seldinger technique was used for insertion of a 16 Gauge double-lumen catheterone day prior to the surgery in day stay unit OT.

Ultrasound studies was done with Color Doppler ultrasound (Sonosite), 5-MHz probe. With the patient lying supine, the short- and long-axis views of the right IJV were imaged from angle of mandible to root of neck and the IJV valve was identified. The area of IJV in the short-axis view was measured immediately distal to the valve during spontaneous breathing at end expiration and during Valsalva manoeuvre (Airway pressure 30mm of hg, maintained for 10 seconds). VM was considered effective if the IJV diameter increased more than 0.8 cm.

The blood flow through the IJV valve was then imaged in the long-axis view by using color doppler ultrasound, and the competence of the IJV valve was assessed during Valsalva manoeuvres at three different intervals i.e. (T1) preoperative (baseline, before cannulation of the IJV), (T2) one week after insertion of catheter and (T3) one month after catheter removal.

Grading of IJVVI was done by measurement of retrograde IJV blood flow duration at rest and during Valsalva manoeuvres. Gradingwas 0, 1, 2 and 3 according to the regurgitant blood flow duration of 0-0.2, 0.2-0.4, 0.4-0.6 and more than 0.6 seconds respectively. Reduction of flow velocity andzero flowduring VMs were rated as competent jugular valves.

Exclusion Criteria

Patients with prior IJV cannulation, infection at site of cannulation, coagulopathy (platelet count < 50,000 cells per cmm, INR > 1.5), Superior Vena Cava obstruction syndrome, history of chemotherapy, radiotherapy, presence of carotid disease, contralateral diaphragmatic dysfunction, thyromegaly or prior neck surgery, pre-existing incompetence of the IJV valve, pulmonary infection, decompensated congestive heart failure, 2D Echo suggestive of EF< 60%, pulmonary artery pressure > 25 mm of Hg, history of prior pulmonary embolism, COPD patients, patients with FEV1/ FVC < 50% and neuro compromised patients were excluded.

Results

Table 1 shows demographic details in both the groups. The two groups were similar regarding gender and age. In the higher cannulation group, there were 22 men and 8 women with a mean age of 45 ± 7.24 yrs. In the lower cannulation group, there were 24 men and 6 women with a mean age of 44 ± 8.02 yrs.

Table 2 shows incidence of incompetence of IJVV in both the groups at different time intervals ((T1) Preoperative, (T2) with catheter in IJV at one weekand (T3) one month after catheter removal), both during normal respiration the and during Valsalva manoeuvre).

Incidence of IJVV incompetence at T2 was significantly higher in the lower cannulation group

Table 1: Shows Demographic Details

Variables	Group H	Group L
No of patients	30	30
M:F	22:8	24:6
Age (Yrs.)	45+7.24	44+8.02

Table 2: shows Grading of IJVV Reflux at Different Intervals.

Reflux Grading	Duration (sec)	High approach (No of Pts) (%)(T2/T3)	Low approach (No of Pts) (%) (T2/T3)
0	0.0-0.2	24 (80.00%)/26 (86.66%)	21 (66.6%)/24 (80.00%)
1	0.2-0.4	2 (6.66%)/2 (6.66%)	4 (13.33%)/3 (10.00%)
2	0.4-0.6	3 (10.00%)/2 (6.66%)	4 (13.33%)/3 (10.00%)
3	>0.6	1 (3.33%)/0(0%)	1 (3.33%)/0(0%)

Table 3: Shows Incidence of Incompetence of IJVV at Different Intervals

Group	Pre-op (T1)	With catheter (T2)	Catheter removed (T3)
High approach	-	6(20%)	4(13.33%)
Low approach	-	9 (30%)	6 (20 %)
		p=0.117	p=0.128
IJV Diameter (cm)(H/L) (Normal respiration)	1.2+0.3 /1.1+0.8	1.8+0.4 /1.7+0.6*	1.9+0.8 / 1.8+0.2*
IJV diameter (cm) (H/L) (Valsalva Manoeuvre)	1.8+0.4 /1.7+0.6	1.9+0.7/2.3+0.7*	1.9+0.8/2.3+0.9*

*IJV area is significantly larger than at baseline (p<0.001)

as compared to higher cannulation group (H/L) (20% vs. 30% p=0.117). At T3 also incidence of IJVV incompetence was higher in lower cannulation group as compared to higher cannulation group (H/L) (13% vs. 20% p=0.128).

Area of the Internal Jugular Vein in the Short-axis View

At T1, area of IJV was comparable in both higher and lower groups during both normal respiration (H/L) (1.2±0.3 /1.1 ± 0.8) and with Valsalva manoeuvre (H/L) (1.8 ± 0.4 /1.7 ± 0.6).

With normal respiration, IJV diameter at T2, T3 was (H/L) (1.8 ± 0.4 /1.7 ± 0.6*) and (1.9 ± 0.8 / 1.8 ± 0.2*) respectively. With Valsalva manoeuvre, IJV diameter at T2, T3 was (H/L) (1.9 ± 0.7/2.3 ± 0.7*) and (1.9 ± 0.8/2.3 ± 0.9*) respectively. During Valsalva manoeuvres, these increases were significantly higher than T1 at both T2 and T3, in lower cannulation group (p<0.001) but less prominent and failed to reach statistical significance in higher cannulation group.

Incompetence of Internal Jugular Vein valve in the long-axis View

Table 3 shows Grading of incompetence of IJVV according to regurgitant jet flow across the IJV valvewith Valsalva manoeuvrein both the groups. Grading was 0, 1, 2 and 3 for 0-0.2, 0.2-0.4, 0.4-0.6 and >0.6 seconds duration of regurgitant blood flow across the IJV valve respectively.

In high approach group, at (T2), 2 (6.66%), 3 (9.99%) and 1 (3.33%) patients manifested 1, 2 and 3 grade regurgitate flow respectively. In low approach group, at (T2), 4 (13.33%), 4(13.33%) and 1 (3.33%) patients manifested 1, 2 and 3 grade regurgitant flow respectively. Overall 20% pts in high approach group and 30% of pts in low group at T2 manifested regurgitate flow across the IJVV. In high approach group, at (T3), 2 (6.66%), 2 (6.66%) and 0 (0%) patients manifested 1, 2 and 3 grade regurgitate flow respectively. In low approach group, at (T3), 3 (10%), 3 (10%) and 0 (0%) patients manifested 1, 2 and 3 grade regurgitant flow respectively. Overall 13% pts in high approach group and 20% of pts in low group at T3 manifested regurgitate flow across the IJVV.

Discussion

Cannulation and catheterization of the IJV frequently causes incompetence of the IJV valve, and that valvular incompetence persisting after removal of the catheter. This complication has been recently hypothesized by Imai et al. [6] based on

autopsy experiments. The fragile IJV valve may be abraded by the catheter, as previously found in another autopsy study, or the closure of the IJV valve may be impaired by the central venous catheter even though the structure of the IJV valve remains intact [4,1]. Competence of the IJV valves is important for protecting the brain from acute increases in intrathoracic pressure, such as during coughing and positive pressure ventilation [11,12]. Second, competence of the IJV valves has been found to be crucial for developing transcranial blood pressure gradient during cardiopulmonary resuscitation with closed chest compression [9,10]. IJVV incompetence is seen in patients who have an elevated central venous pressure, such as congestive heart disease, tricuspid valve regurgitation, primary pulmonary hypertension, and chronic obstructive pulmonary disease [15,16]. In vitro, internal jugular valves can be competent up to static pressures of 100 mm Hg [14]. These findings support the hypothesis thatthe venous valve incompetence is acquired and is linked to venous hypertension [15,16].

Imai et alreported that the valves can be damaged by a 14-gauge needle. After such a needle puncture, formerly competent valves become incompetent at pressures of 5 mm Hg. Imai et al. saidthat the probability of inducing valvular incompetence is higher if the IJV is cannulated proximally, i.e., in the area where the IJV valve is located (below the cricoid level). However, even when the IJV was cannulated more distally (above the cricoid level), incompetence of the IJV valve occurred and persisted after removal of the central venous catheter in 13 of 46 patients (28%). This incidence failed to be significantly lower than that in the proximal cannulation group [6].

In our study, with Valsalva manoeuvre, incidence of incompetence of IJVV at T2 was significantly higher in the lower cannulation group as compared to higher cannulation group (H/L) (20% vs. 30% p=0.117). At T3, incidence of IJVV incompetence was higher in lower cannulation group as compared to higher cannulation group (H/L) (13% vs. 20% p=0.128).

Malcolm Watters in his study found that incompetence of the jugular vein valve was frequently found postoperatively, 76% with the low approach, 41% with the high approach (statistically significant) and it persisted when the catheter was removed (47% low and 28% high). In total, 24 patients still had incompetence at late testing [7,14].

Xianren Wu studied the area of the IJV in the short-axis view and stated that in both groups, the area of IJV at end expiration was significantly larger at T2 and T3 than at T1. They said that the increased size of the IJV may have changed geometry and function of the IJV valve and thus may have been the cause for alular incompetence in some patients [14]. He said that during Valsalva manoeuvres, the increases were less prominent and failed to reach statistical significance inthe proximal cannulation group [14].

In our study, IJV diameter with Valsalva Manoeuvre was significantly high ($p<0.001$) in lower cannulation group at both T2 and T3 as compared to T1. During Valsalva manoeuvres, these increases were less prominent and failed to reach statistical significance in the higher cannulation group.

Nedelmann et al. directly insonated the IJVV and proposed cut-off values to differentiate transient reflux caused by valve closure from real IJVVI. They reported valve closing times ranging from 0.22 to 0.78 seconds in patients with competent valves. This resulted in IJVVI prevalence significantly lower ($p < 0.0001$) in their controls (13%) than in our COPD patients (53%) [15].

Wu et al. developed a grading scale (grades 0–4) for IJVVI based on the visible width of the regurgitation jet and its duration [14]. He stated that even when the IJV was cannulated more distally (above the cricoid level), incompetence of the IJV valve occurred and persisted after removal of the central venous catheter in 13 of 46 patients (28%). This incidence failed to be significantly lower than that in the proximal cannulation group [14].

In our study, regurgitant blood flow more than 0.2 seconds was considered as IJVVI. At T2 and T3 with Valsalva manoeuvre, in high approach group 20% and 13% ptsand in low approach 30%and 20% of pts manifested regurgitant flow in the IJV with Valsalva manoeuvre.

Akkawi used air contrast ultrasonographic venography (ACUV) flow with ACUV on a large sample of healthy subjects and showed retrograde jugular venous flow in a relatively high number of subjects (38.4%) [10,8]. This thorough study could avoid any underestimation of the frequency of JVR in normal individuals and in patients with neurologic disorders, which are thought to be caused by cerebral venous outflow impairment [8]. According to Florin et al., the reflux was moderate or small in most (96%) of the controls with IJVVI and in 61% of the COPD patients and none of the PPH patients. They noted high reflux pattern in 39% of COPD patients with IJVVI and 100% of PPH patients [17].

Potential concerns about the study are that the intrathoracic pressure during Valsalva manoeuvrewas not directly measured and its adequacy was only indirectly assessed by the IJV diameter changes as described above [14]. Increase in IJV diameter at T2 and T3 with Valsalva manoeuvre may be related to changing intravascular volume status and relevant central venous pressure changes reflecting on cross sectional area of IJV [4,5]. The study is showing the IJVV incompetence results only with IJV cannulation with small gauge needle [6].

In conclusion, anaesthesiologists should be aware of the presence of IJV valves. Cannulation and catheterization of the IJV may cause persistent incompetence of the IJV valve. Taking a more distal site for venous cannulation may slightly lower the risk of causing incompetence of the valve but does not reliably eliminate the risk [14]. A larger sample size and prolonged follow up and the help of other imaging modalities like diffusion-weighted MRI for evaluation of IJV diameter, reflux velocity and assessment of the branches of the IJV, mayprove useful in this context in future [16,19,20].

References

1. Harvey W. Cardiac Classics. St Louis: CV Mosby, 1941:19.
2. Chi-Hsiang Chou, A-Ching Chao, and Han-Hwa Hu. Ultrasonographic Evaluation of Vertebral Venous Valves. AJNR Am J Neuroradiol September 2002;23:1418–20.
3. Fukazawa K, Aguina L, Pretto EA Jr. Internal jugular valve and central catheter placement. Anesthesiology. 2010;112:979.
4. Manish S. Raut, Maheshwari Arun. Difficult venous catheterization in internal jugular vein Annals of cardiac anesthesia. Jan-March. 2015;18(1):106.
5. Knappertz VA. Cough headache and the competency of jugular venous valves (letter). Neurology. 1996;46:1497.
6. Imai M, Hanaoka Y, Kemmotsu O: Valve injury: A new complication of internal jugular vein cannulation. Anesth Analg 1994.
7. Malcolm Watters. Valve incompetence: a hazard of internal jugular vein Cannulation. Biomed Central. Current Science Ltd. 2000;82:1-3.
8. Chih-Ping Chung, Han-Hwa Hu1. Jugular Venous Reflux. J Med Ultrasound. 2008;16(3):210–22.
9. Akkawi NM, Agosti C, Rozzini L, et al. Transient global amnesia and venous flow patterns. Lancet. 2001;357:639.
10. Akkawi NM, Agosti C, Borroni B, et al. Jugular valve incompetence: a study using air contrast ultrasonography on a general population. J Ultrasound Med. 2002;21:747–51.
11. Chung CP, Hsu HY, Chao AC, et al. Flow volume in the jugular vein and related hemodynamic in the branches of the jugular vein. Ultrasound Med Biol. 2007;33:500–5.
12. Chuang YM, Hu HH. Cough headache and thoracic inlet valvular competence in uraemia. Eur Neurol. 2005;53:78–80.
13. Doepp F, Valdueza JM, Schreiber SJ. Incompetence of internal jugular valve in patients with primary exertional headache: a risk factor? Cephalalgia. 2008;28:182–5.
14. Xiamen Wu, Wolfgang Studer, Thomas Erb, Karl Skarvan. Competence of the internal Jugular Vein Valve is Damaged by Cannulation and Catheterization of the Internal Jugular Vein. Anesthesiology. 2000;93:319–24.
15. Nedelmann M, Eicke BM, Dieterich M. Functional and morphological criteria of internal jugular valve insufficiency as assessed by ultrasound. J Neuroimaging. 2005;15:70–5.
16. ST (John) Sum-Ping. Internal Jugular Valves: Competent or Incompetent? Anesth Analg. 1994;78:1039-40.
17. Florian Doepp, Dieter Ba¨hr, Matthias John, So¨ren Hoernig. Internal Jugular Vein Valve Incompetence in COPD and Primary Pulmonary Hypertension. Journal of Clinical Ultrasound. 2008;36(8):480-84.
18. Ma'moon Hasan Al-Omari, Areen Al-Bashir. Internal Jugular Vein Valve Morphology in the Patients with Chronic Cerebrospinal Venous Insufficiency (CCSVI); Angiographic Findings and Schematic Demonstrations. Reviews on Recent Clinical Trials. 2012;7:1
19. Claudia Cejas, Lucia Fernandez Cisneros, Roberto Lagos, Carlos Zuk, Sebastia´n F. Ameriso. Internal Jugular Vein Valve Incompetence Is Highly Prevalent in Transient Global Amnesia. Stroke. 2010 Jan;68:67-71.
20. Takahiro Tadokoro, Kouji Yoza, Kazuhiro Sugahara. Guide wire advancement is interrupted by an internal jugular vein valve with a restricted opening: an ultrasound image. Can J Anesth. 2013;60:1163–64.