

## **Flow volume in the jugular vein and related hemodynamics in the branches of the jugular vein.**

Chung CP, Hsu HY, Chao AC, Wong WJ, Sheng WY, Hu HH.

Section of Neurovascular Diseases, Neurological Institute, Veterans General Hospital-Taipei, Taipei, Taiwan.

### **Abstract**

Venous reflux in the internal jugular vein branches (JB) was found frequently in patients of certain neurologic disorders. We hypothesized that the retrograde-flow in JB is associated with retrograde hypertension transmitted from the internal jugular vein (IJV), which presumably underlies those neurologic disorders. In this study, we used color-Doppler imaging to evaluate the dynamic venous flow patterns in the IJV and its branches in 50 normal individuals (21 men, 29 women; mean age: 40.9 +/- 14.9 y, range: 22 to 70 y). The flow-direction of all detected JB (n = 100) was flowing into the IJV at baseline. During the Valsalva maneuver (VM), 38 JB (38%) had a retrograde-flow. Retrograde-flow in JB was significantly associated with IJV valve incompetence (OR = 7.6; 95% CI = 2.6 to 21.8; p = 0.0002) and greater IJV blood flow volume (blood flow volume >670 mL/min) (OR = 6.6; 95% CI = 1.8 to 24.5; p = 0.0052), both of which may reflect higher IJV pressure transmission during VM. The sonographic findings can be used in the future studies of diseases that are suspected to be related with retrograde cerebral venous hypertension due to an elevated IJV venous pressure.

<http://www.ncbi.nlm.nih.gov/pubmed/17337108>

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J Clin Ultrasound. 1994 Jul-Aug;22(6):367-73.

## **Doppler ultrasonography of normal neck veins.**

Pucheu A, Evans J, Thomas D, Scheuble C, Pucheu M.

### **Abstract**

Doppler ultrasonography was used to examine 198 neck-vein systems (67 right, 131 left) in 148 patients. The vessel lumen is usually echo-free: the veins are supple, and the internal jugular and sometimes the subclavian veins can be compressed. The venous confluence is Y-shaped. Blood flow was symmetrical and biphasic in 57% of cases, continuous in 29% of cases, and monophasic in 13% of cases. Blood flow velocity was less than 1 m/s in all cases and varied with respiration and heart rate. Color Doppler allows flow imaging and increases the speed and reliability of the procedure. This investigation is useful for following-up patients with indwelling venous catheters and is the investigation of choice whenever pathology of the neck veins is suspected.

<http://www.ncbi.nlm.nih.gov/pubmed/8071454>

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Auris Nasus Larynx. 2001 Jan;28(1):71-4.

## **Reproducibility of ultrasonographic measures in internal jugular veins of normal subjects.**

De Diego JI, Prim MP, Garcia-Raya P, Madero R, Gavilan J.

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### **Abstract**

**OBJECTIVE:** To assess the reproducibility of ultrasonographic quantitative parameters of internal jugular veins (IJV) in normal subjects. **MATERIAL AND METHODS:** Thirty IJV of 15 normal volunteers were prospectively evaluated by means of duplex Doppler ultrasonography (US). Patency, presence of thrombosis, characteristics of the vein wall, compressibility, area of vein both in rest and during Valsalva maneuver, expiratory flow speed, Valsalva flow speed, jugular flow in each side, and total jugular flow were registered in all cases. Two measures were performed in each subject. **RESULTS:** High reproducibility was encountered in jugular flow ( $R=0.95$ ) and in area during Valsalva ( $R=0.90$ ) in the left IJV. Low reproducibility was found in Valsalva flow speed of the left side ( $R=0.35$ ). The remaining measurements had a good reproducibility ( $R=0.50-0.75$ ). **CONCLUSIONS:** The ultrasonographic parameters of IJV in normal subjects show an adequate grade of reproducibility. Thus, duplex Doppler US can be used as a reliable method for evaluation or comparison of IJV in different situations of future studies.

<http://www.ncbi.nlm.nih.gov/pubmed/11137366>

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Cen Eur Neurosurg. 2010 Jun 15. [Epub ahead of print]

## **Position Dependent Changes of the Cerebral Venous Drainage - Implications for the Imaging of the Cervical Spine.**

Niggemann P, Kuchta J, Grosskurth D, Beyer HK, Krings T, Reinges M.

Privatpraxis für Upright MRT, Radiology, Köln, Germany.

### **Abstract**

**PURPOSE:** This study demonstrates the physiological changes of the cerebral venous outflow routes in healthy humans in the recumbent and the sitting position employing positional MRI. **METHODS:** In five volunteers, the internal jugular veins and the cervical vertebral plexus

were analyzed in the supine and sitting position using an open MR system. Axial T2-weighted scans and axial T1-weighted flow sensitive gradient echo sequences were acquired. The findings were compared to previously published anatomic descriptions from cadaver preparations. RESULTS: In the supine position, the internal jugular vein is the main route for the cerebral venous outflow. The mean area was 100 mm<sup>2</sup> (+/-29 mm<sup>2</sup>) for both sides together. In the sitting position, the jugular vein collapses (mean area: 11 mm<sup>2</sup> +/-2 mm<sup>2</sup>) and the vertebral venous plexus becomes more prominent. CONCLUSION: The position dependent changes in cerebral venous outflow can be imaged using positional MRI. The vertebral venous plexuses may mimic pathologies and physicians reading positional MRI images of the cervical spine should be aware of the physiological changes occurring in the erect position. © Georg Thieme Verlag KG Stuttgart · New York.

<http://www.ncbi.nlm.nih.gov/pubmed/20552542>

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J Neuroimaging. 1991 May;1(2):74-8.

## **Ultrasonic imaging of the internal jugular vein.**

Müller HR.

Neurological Clinic, University Hospital, Basel, Switzerland.

### **Abstract**

The ultrasonographic anatomy of the internal jugular vein is described. Current uses of ultrasonic imaging of this vessel are discussed, with special attention given to its use for calculating volume flow.

<http://www.ncbi.nlm.nih.gov/pubmed/10149804>

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Ital J Anat Embryol. 1994 Apr-Jun;99(2):123-7.

## **The valves of the internal jugular veins: a statistical investigation in 120 living subjects using ultrasonic tomography.**

Macchi C, Catini C.

Institute of Gerontology and Geriatric Medicine, University of Florence, Italy.

### **Abstract**

We examined both jugular veins of 120 healthy subjects (60 men, 60 women; age range: 18 to 90 years); thus, a total of 240 jugular veins were examined. The vessel diameter was measured by color Doppler ultrasonography, and when valves were present at the ostial level, their morphology and competence were assessed. A single valvular apparatus was detected in

206 cases (86%). It consisted of 2 cusps in 75% of these 206 cases, of one in 15%, and of three in 10%. No correlations with side or the subjects' sex, age, height, or body weight were observed. In the 34 cases in which a valvular apparatus was not visualized, we found a male predominance (22 men as compared to 12 women). **The mean diameter of the jugular vein at the ostial level was 13.8 mm**, with that of the men being significantly larger than that of the women ( $p < 0.01$ ), and it showed a tendency to increase with age. The valves were observed to be incompetent in 95% of the cases.

<http://www.ncbi.nlm.nih.gov/pubmed/7741605>

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J Cardiothorac Vasc Anesth. 1999 Apr;13(2):136-8.

## **Cross-sectional area of the right and left internal jugular veins.**

Lobato EB, Sulek CA, Moody RL, Morey TE.

Department of Anesthesiology, University of Florida College of Medicine, Gainesville 32610-0254, USA.

### **Abstract**

**OBJECTIVE:** To compare the cross-sectional area (CSA) of the right internal jugular vein (RIJV) with the left internal jugular vein (LIJV) using two-dimensional ultrasound and to measure the response to the Valsalva maneuver in both the supine and Trendelenburg positions. **DESIGN:** Prospective and randomized. **SETTING:** University-affiliated hospital. **PARTICIPANTS:** Fifty healthy adult volunteers. **INTERVENTIONS:** **The CSA of both the RIJV and LIJV was measured with a 5-MHz, two-dimensional surface transducer before and during a 10-second Valsalva maneuver with the subjects in the supine position, and then with the subjects in a 10 degree Trendelenburg tilt.** **MEASUREMENTS AND MAIN RESULTS:** After the baseline measurements were performed, the subjects were divided into two groups based on the CSA of the RIJV and LIJV. Group 1 had an LIJV CSA equal to or greater than that of the RIJV ( $n = 10$ ) and group 2 had an LIJV CSA less than that of the RIJV ( $n = 40$ ). Of the latter 40 patients, 17 (34%) had an LIJV CSA less than 50% of that of the RIJV. In both groups, the CSA of both veins increased significantly with the Valsalva maneuver, Trendelenburg tilt, and both maneuvers combined. **CONCLUSION:** The findings suggest that in one third of adults (34%), the LIJV is significantly smaller compared with the RIJV and, combined with operator inexperience, may influence the success rate and risk for complications. Thus, the use of ultrasound and maneuvers that increase CSA is suggested during LIJV cannulation.

<http://www.ncbi.nlm.nih.gov/pubmed/10230944>

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Ann Emerg Med. 1999 Jul;34(1):115.

## **Determination of elevated jugular venous pressure by real-time ultrasound.**

Lipton BM.

<http://www.ncbi.nlm.nih.gov/pubmed/10409088>

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J Pak Med Assoc. 2001 Mar;51(3):105-9.

## **Anatomical variations of internal jugular vein as seen by "Site Rite II" ultrasound machine--an initial experience in Pakistani population.**

Hameedullah, Rauf MA, Khan FH.

Department of Anaesthesia, Aga Khan University Hospital, Karachi.

### **Abstract**

**OBJECTIVE:** To determine the anatomical variations of the internal jugular vein (IJV) in Pakistani adult population with the help of Site Rite II ultrasound machine. **MATERIAL AND METHOD:** The right IJV relation to the carotid artery was visualized at four different landmarks (angle of the mandible, thyroid cartilage, cricoid cartilage, and the supraclavicular area). Size of IJV in comparison to carotid artery was also seen. **RESULTS:** In 49 cases the IJV was found in aberrant relation to carotid artery at the angle of the mandible ( $p$  value  $< 0.05$ ), 22 at the thyroid cartilage, 20 at the cricoid cartilage, and 46 at the supraclavicular area ( $p$  value  $< 0.05$ ). In 93% of cases the IJV was found to be larger than the carotid artery. **CONCLUSION:** Care should be taken while cannulating IJV at the angle of the mandible and supra clavicular area by external landmark guided technique. Ultrasound guided technique should be used in every anticipated difficult case.

<http://www.ncbi.nlm.nih.gov/pubmed/11381821>

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Masui. 2001 Nov;50(11):1186-8.

## **[Change of cross-sectional area of the right internal jugular vein: effect of Trendelenburg position and valsalva maneuver]**

[Article in Japanese]

Shimizu T, Miyabe M, Takahashi H, Toyooka H.

Department of Anesthesia, Tsukuba University Hospital, Tsukuba 305-8576.

## Abstract

To compare the effect of Valsalva maneuver and 10 degrees Trendelenburg position on the right internal jugular vein (RIJV), we measured RIJV cross-sectional area using ultrasound imaging during these procedures. The study group consisted of 13 normal healthy volunteers (6 males, 7 females, aged 25-47) with no history of neck surgery or right internal jugular vein (RIJV) puncture. All ultrasound images were obtained at the level of the cricoid cartilage. The subjects were positioned supine, and the measurements were taken with the subjects supine, under Valsalva maneuver, and under 10 degrees Trendelenburg tilt position. The cross-sectional areas of the RIJV during Valsalva maneuver and 10 degrees Trendelenburg position compared to those with supine position were 314 +/- 162%, and 192 +/- 96%, respectively. We conclude that both procedures increase cross-sectional area of IRJV significantly and in this respect Valsalva maneuver is more effective than Trendelenburg position.

<http://www.ncbi.nlm.nih.gov/pubmed/11758320>

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Aviat Space Environ Med. 2003 Feb;74(2):125-31.

## The effect of posture and positive pressure breathing on the hemodynamics of the internal jugular vein.

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## Abstract

**BACKGROUND:** Mathematical and mechanical models of cerebral circulation indicate that the resistance of the collapsed internal jugular veins limits cerebral blood flow during high acceleration (+Gz) and that positive pressure breathing (PPB) restores cerebral blood flow by elevating blood pressure and preventing collapse of the vein. The effect of acceleration and PPB on the jugular resistance and flow can be estimated by documenting changes in the lumen area and blood velocity. **METHODS:** The right internal jugular vein was imaged with vascular ultrasound in supine and seated human subjects exposed to 0-50 mm Hg of PPB. For each of the PPB posture combinations the vein was imaged at four locations along the length; resistance and flow were calculated using Poiseuille flow approximation. **RESULTS:** For the supine subjects, the lumen area, just above the inferior bulb, was 1.0 +/- 0.49 cm<sup>2</sup>, the estimated resistance was 0.13 +/- 0.07 x 10<sup>(-3)</sup> mm Hg x cm<sup>(-3)</sup> x min<sup>(-1)</sup>, and the estimated blood flow was 931 +/- 477 cm<sup>3</sup> x min<sup>(-1)</sup>. In the sitting position, the lumen narrowed to 0.11 +/- 0.07 cm<sup>2</sup>, the resistance increased to 6.3 +/- 4.9 x 10<sup>(-3)</sup> mm Hg x cm<sup>(-3)</sup> x min<sup>(-1)</sup>, and the blood flow dropped to 372 +/- 194 cm<sup>3</sup> x min<sup>(-1)</sup>. However, the vessel of a sitting subject can be completely reopened with PPB of 30 mm Hg or higher, and the resistance can be brought to supine levels. **CONCLUSIONS:** The results demonstrate that the internal jugular vein collapses with transition from supine to sitting position. This implies a significant increase in resistance which is inversely proportional to the square of the lumen area. However, the collapse can be prevented with sufficiently high PPB.

<http://www.ncbi.nlm.nih.gov/pubmed/12602443>

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Neuroradiology. 2004 Jul;46(7):565-70. Epub 2004 May 15.

## **How does the blood leave the brain? A systematic ultrasound analysis of cerebral venous drainage patterns.**

Doepp F, Schreiber SJ, von Münster T, Rademacher J, Klingebiel R, Valdueza JM.

Department of Neurology, University Hospital Charité, Schumannstr. 20/21, 10117, Berlin, Germany. florian.doepp@charite.de

### **Abstract**

The internal jugular veins are considered to be the main pathways of cerebral blood drainage. However, angiographic and anatomical studies show a wide anatomical variability and varying degrees of jugular and non-jugular venous drainage. The study systematically analyses the types and prevalence of human cerebral venous outflow patterns by ultrasound and MRI. Fifty healthy volunteers (21 females; 29 males; mean age 27+/-7 years) were studied by color-coded duplex sonography. Venous blood volume flow was measured in both internal jugular and vertebral veins in the supine position. Furthermore, the global arterial cerebral blood volume flow was calculated as the sum of volume flows in both internal carotid and vertebral arteries. Three types of venous drainage patterns were defined: a total jugular volume flow of more than 2/3 (type 1), between 1/3 and 2/3 (type 2) and less than 1/3 (type 3) of the global arterial blood flow. 2D TOF MR-venography was performed exemplarily in one subject with type-1 and in two subjects with type-3 drainage. Type-1 drainage was present in 36 subjects (72%), type 2 in 11 subjects (22%) and type 3 in 3 subjects (6%). In the majority of subjects in our study population, the internal jugular veins were indeed the main drainage vessels in the supine body position. However, a predominantly non-jugular drainage pattern was found in approximately 6% of subjects.

<http://www.ncbi.nlm.nih.gov/pubmed/15258709>

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Resuscitation. 2005 Feb;64(2):193-9.

## **Estimation of central venous pressure by ultrasound.**

Baumann UA, Marquis C, Stoupis C, Willenberg TA, Takala J, Jakob SM.

Department of Internal Medicine, Regional Hospital, 3110 Münsingen, Switzerland.

### **Abstract**

**INTRODUCTION:** Increasing blood volume and cardiac output is one of the most commonly needed intervention in the primary care of traumatized and severely ill patients. Although

cardiac filling pressures have severe limitations in assessing the preload, central venous pressure (CVP) is the invasive measure most frequently used in clinical practice for the assessment of volume status and cardiac preload. We combined ultrasound and tissue pressure measurement for non-invasive jugular and brachial venous pressure estimation. **MATERIALS AND METHODS:** CVP was measured invasively and non-invasively using the new technique in 32 critically ill patients. In six volunteers, increasing PEEP was used for the assessment of changes in non-invasive CVP. **RESULTS:** Non-invasive CVP increased linearly with increasing PEEP, independent of the investigator. Median (range) coefficient of variation (CV) for five consecutive measurements performed by three investigators in volunteers was 15% (6-31%), 14% (4-31%), and 21% (8-42%). Absolute differences between the average non-invasive CVP between investigators was 1.7 cm H<sub>2</sub>O (0.4-6.6 cm H<sub>2</sub>O), and the inter-examiner CVP was high (182%, 40-415%). In patients, invasive CVP was 10 mmHg (5-18 mmHg), and the corresponding non-invasive venous pressures were 8 mmHg (3-14 mmHg, basilic vein, p<0.01) and 6 mmHg (3-13 mmHg, jugular vein, p<0.01). The coefficients of variation were 4% (<1%-64%, invasive CVP), 22% (5%-51%, non-invasive basilic vein pressure), and 17% (7%-34%, non-invasive jugular vein pressure). **CONCLUSION:** Ultrasound-based, non-invasive measurement of venous pressure provides a relatively easy method rapid estimation of changes in CVP, although absolute values may differ substantially from invasive CVP and between different investigators.

<http://www.ncbi.nlm.nih.gov/pubmed/15680529>

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Emerg Med J. 2005 Dec;22(12):867-8.

## **Relationship between Trendelenburg tilt and internal jugular vein diameter.**

Clenaghan S, McLaughlin RE, Martyn C, McGovern S, Bowra J.

Ulster Hospital, Belfast, Northern Ireland. stepclen@hotmail.com

Comment in:

- [Emerg Med J. 2006 Aug;23\(8\):661.](#)

### **Abstract**

**OBJECTIVES:** To evaluate the relationship between Trendelenburg tilt and internal jugular vein (IJV) diameter, and to examine any cumulative effects of tilt on the IJV diameter.

**METHODS:** Using a tilt table, healthy volunteers were randomised to Trendelenburg tilts of 10 degrees, 15 degrees, 20 degrees, 25 degrees, and 30 degrees. Ultrasound was used to measure and record the lateral diameter of the right IJV at the level of the cricoid cartilage. Following each reading the table was returned to the supine position. Balanced randomisation was used to assess cumulative tilt effects. **RESULTS:** A total of 20 healthy volunteers were recruited (10 men, 10 women). Mean supine IJV diameter was 13.5 mm (95% CI 12.8 to 14.1) and was significantly greater at 10 degrees (15.5 mm, 95% CI 14.9 to 16.1). There was no significant difference between 10 degrees and greater angles of tilt. The effect of the

previous angle of tilt did not prove to be statistically significant. **CONCLUSION:** Increasing the degree of Trendelenburg tilt increases the lateral diameter of the IJV. Even a 10 degrees tilt is effective. The cumulative effect of tilt (that is, the effect of the previous angle) is not significant. Ultrasound guided cannulation is ideal, but in its absence Trendelenburg tilt will increase IJV diameter and improve the chance of successful cannulation. While 25 degrees achieved optimum distension, this may not be practical and may be detrimental (for example, risk of raised intracranial pressure).

<http://www.ncbi.nlm.nih.gov/pubmed/16299195>

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Ann Emerg Med. 2007 Jul;50(1):73-7. Epub 2007 Apr 11.

## **Humming is as effective as Valsalva's maneuver and Trendelenburg's position for ultrasonographic visualization of the jugular venous system and common femoral veins.**

Lewin MR, Stein J, Wang R, Lee MM, Kernberg M, Boukhman M, Hahn IH, Lewiss RE.

Division of Emergency Medicine, University of California, San Francisco, CA 94143, USA.  
aplysia99@yahoo.com

### **Abstract**

**STUDY OBJECTIVE:** The purpose of this study is to compare ultrasonographic visualization of the jugular and common femoral veins by using a novel technique (humming) and 2 conventional techniques (Valsalva's maneuver and Trendelenburg's position). The Valsalva's maneuver and Trendelenburg's position are common methods for producing venous distention, aiding ultrasonographically guided identification and cannulation of the jugular and common femoral veins. We hypothesize that humming is as effective as either Valsalva's maneuver or Trendelenburg's position for distention and ultrasonographic visualization of these procedurally important blood vessels. Herein, we investigate a new method of venous distension that may aid in the placement of central venous catheters by ultrasonographic guidance. **METHODS:** Healthy, normal volunteers aged 28 to 67 years were enrolled. Each subject's internal jugular, external jugular, and common femoral veins were measured in cross-section by ultrasonograph during rest (baseline), humming, Valsalva's maneuver, and Trendelenburg's position. Three measurements were recorded per observation in each position. Subjects were used as their own controls, and measurements were normalized to percentage increase in diameter during each maneuver or position for later comparison.

**RESULTS:** The study population consisted of 7 subjects, with a mean age of 47 years. **Cross-sectional area was calculated for each vessel in 3 groups: baseline/control, Valsalva, Trendelenburg, and humming.** The mean percentage change (+/-SD) relative to baseline cross-sectional area of the jugular vessels for each subject were external jugular vein: humming 134% +/- 25% (95% confidence interval [CI] 124.9% to 146.9%), Valsalva 136% +/- 23% (95% CI 121.3% to 147.5%), Trendelenburg 137% +/- 32% (95% CI 120.7% to 156.9%); internal jugular vein: humming 137% +/- 27% (95% CI 119.4% to 148.2%), Valsalva 139% +/- 24% (95% CI 122.4% to 148.7%), Trendelenburg 141% +/- 35% (95% CI 116.5% to 156.5%); common femoral vein: humming 131% +/- 15% (95% CI 120.4% to 139.1%), Valsalva

139% $\pm$ 18% (95% CI 127.9% to 150.4%), Trendelenburg 132% $\pm$ 24% (95% CI 113.3% to 142.9%). CONCLUSION: All 3 maneuvers distended the external jugular, internal jugular, and common femoral veins compared to baseline. There was no important difference in magnitude of cross-sectional area between any of the 3 maneuvers when compared with one another. Humming shares many physiologic similarities to Valsalva's maneuver and may be more familiar and easier to perform during procedures such as ultrasonographically guided central venous catheter placement and insertion of external jugular intravenous catheters.

<http://www.ncbi.nlm.nih.gov/pubmed/17433497>

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Leg Med (Tokyo). 2009 Jan;11(1):10-7. Epub 2008 Sep 26.

## **Assessment of cervical venous blood flow and the craniocervical venous valve using ultrasound sonography.**

Morimoto A, Takase I, Shimizu Y, Nishi K.

Department of Legal Medicine, Shiga University of Medical Science, Otsu, Shiga, Japan.  
gtr9876@belle.shiga-med.ac.jp

### **Abstract**

Severe congestion with petechiae and/or small hemorrhages over a wide area consisting of the subcutaneous and mucous level of the head and neck is observed in most cases of strangulation and positional asphyxial death. Congestion present above the strangulation mark is accepted as a vital reaction. Although the congestion results from a disturbance of cervical venous flow, only a few reports concerning a relationship between venous flow and posture were found in the literature. We assessed the physiological situation of cervical venous return and movement of the craniocervical venous valve for many types of valve with respect to posture using color-duplex ultrasound sonography (US). We measured the Doppler wave of cervical veins consisting of internal jugular vein (IJV), external jugular vein (EJV) and vertebral vein (VV) and the motion of IJV valves in three positions on a seat which could be manually moved through +90 degrees to -90. The diameter of IJVs and EJVs were thicker in a head-down position, moderate in a supine position and flat in a sitting position. The diameter of VVs was thick in a sitting position, moderate in supine position and unclear in an upside-down position because of difficulty in scanning owing to very slow velocity and deep lying position. The velocities were high in a sitting position, but very slow and intermittent in an upside-down position. The EJV which is markedly congested in some cardiac tamponade cases and drains mainly the facial superficial region is very important in legal medicine but has not often observed in previous reports. We confirmed that cervical venous return (IJV, EJV, VV) changes its route according to the posture. The motion of IJV valves was very complicated and varied in three positions, even after the Doppler wave and the motion of valve became stable. Asphyxia and strangulation should be studied taking the complex venous structure into consideration. We could not find any consistent explanation for venous valve motion and further studies on the valves are necessary to understand the venous reflux in some diseases in legal medicine.

<http://www.ncbi.nlm.nih.gov/pubmed/18823812>

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J Neurol. 2009 Jun;256(6):964-9. Epub 2009 Mar 1.

## **Venous obstruction and jugular valve insufficiency in idiopathic intracranial hypertension.**

Nedelmann M, Kaps M, Mueller-Forell W.

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### **Abstract**

The pathophysiology of elevated intracranial pressure in idiopathic intracranial hypertension (IIH) is unclear. Cerebral venous outflow obstruction and elevated intracranial venous pressure may play an etiological role. We examined jugular valve insufficiency as a potential factor contributing to intracranial hypertension. Jugular venous valve function was assessed bilaterally by duplex sonography in 20 consecutive patients with diagnosis of IIH and in 20 healthy controls matched for age, gender and body mass index. Diagnosis of valvular insufficiency was based on reflux duration during a controlled Valsalva maneuver. Intracranial venous outflow was evaluated in 11 patients (MR venography in 10, digital subtraction angiography (DSA) in two cases). As a principle result, valvular insufficiency was significantly more frequent in patients with IIH (70 vs. 30%;  $p < 0.05$ ). This finding was associated with irregular leaflet structures on B-mode imaging ( $p < 0.01$ ). Bilateral insufficiency was more frequent in the patient group which, however, was not significant ( $p = 0.08$ ). In addition, sinovenous outflow obstruction was found in five of six patients that had undergone contrast-enhanced MR venography and DSA. The detection rate was inferior in phase-contrast MR imaging (one of five patients). In conclusion, this study gives evidence that valvular insufficiency may play a causal role in IIH. Obesity is a major risk factor for the disease and weight reduction leads to improvement of symptoms. Possibly, increased intra-abdominal pressure is transmitted into the intracranial venous system, causing intracranial hypertension. Jugular valve insufficiency may facilitate pressure transmission. As transverse sinus stenosis was a concomitant finding, these factors may be complementary.

<http://www.ncbi.nlm.nih.gov/pubmed/19252781>

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Am J Emerg Med. 2009 Sep;27(7):851-5.

## **Correlation of sonographic measurements of the internal jugular vein with central venous pressure.**

Donahue SP, Wood JP, Patel BM, Quinn JV.

Department of Emergency Medicine, Stanford University Medical Center, Palo Alto, California, USA.

## **Abstract**

Determination of volume status is crucial in treating acutely ill patients. This study examined bedside ultrasonography of the internal jugular vein (IJV) to predict central venous pressure (CVP). Ultrasonography was performed on 34 nonventilated patients with monitored CVPs. The IJV was measured during the respiratory cycle and with the patient in different positions. Mean IJV diameter in patients with CVP less than 10 cm H<sub>2</sub>O was 7.0 mm (95% confidence interval [CI], 5.7-8.3) vs 12.5 mm (95% CI, 11.2-13.8) in patients with CVP of 10 cm H<sub>2</sub>O and greater. Measurement of end expiratory diameter with the patient supine had the highest correlation coefficient: 0.82 (95% CI). There was strong agreement among ultrasonographers: correlation coefficient, 0.92 (95% CI). This pilot study shows promise that ultrasonography of the IJV can be a noninvasive tool to predict CVP. Measurement of end expiratory diameter in supine patients exhibited a high correlation to CVP.

<http://www.ncbi.nlm.nih.gov/pubmed/19683116>

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J Ultrasound Med. 1990 May;9(5):261-5.

## **Internal jugular venous flow measurement by means of a duplex scanner.**

Müller HR, Hinn G, Buser MW.

\*Department of Neurology, University of Basel, Switzerland.

## **Abstract**

Using a special probe holder, cross-sectional area and time-averaged mean spatial velocity of the internal jugular vein were measured by means of a duplex scanner and multiplied to calculate volume flow. In a cohort of 100 subjects ages 21 to 70 years, average right plus left flow was 740 +/- 209 mL/min. Flow was 8.7% lower in females than in males. Normalization of flow to 100 g brain tissue by dividing it through the mean sex specific brain weight resulted in no significant sex difference. Within the age range investigated, there was no decrease of flow with age.

<http://www.ncbi.nlm.nih.gov/pubmed/2188005>

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Vasa. 1990;19(1):26-9.

## **[Doppler sonography measurement of jugular vein blood flow]**

[Article in German]

Brunhölzl C, Müller HR.

Neurologische Universitätsklinik, Kantonsspital Basel.

## Abstract

By multiplying mean cross section determined with a linear array scanner by time averaged mean spatial velocity measured with a single gated pw Doppler device, internal jugular venous volume flow was computed in 50 healthy male and 50 female volunteers aged 21 to 70 years with even age distribution within this range. Right plus left flow was 793 +/- 276 ml/min in males and 799 +/- 288 ml/min in females. There was no correlation between flow and age.

<http://www.ncbi.nlm.nih.gov/pubmed/2188457>

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Cerebrovasc Dis. 2010 Jan;29(2):122-9. Epub 2009 Dec 1.

## Jugular venous reflux affects ocular venous system in transient monocular blindness.

Chung CP, Hsu HY, Chao AC, Cheng CY, Lin SJ, Hu HH.

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## Abstract

**BACKGROUND:** The frequency of jugular venous reflux (JVR) is higher in patients with transient monocular blindness (TMB). We hypothesize that JVR influences ocular venous outflow, and resulting disturbances in cerebral and ocular venous circulation might be a cause of TMB. To substantiate this hypothesis, we aimed to demonstrate that: (1) TMB patients have vasculature changes in their retinal venules, and (2) JVR could influence ocular venous outflow, as revealed by dilated retinal venules. **METHODS:** This study has 2 parts. The case-control study included 31 TMB patients and 31 age/gender-matched normal individuals, who all received fundus photography for retinal venule diameter comparisons. The Valsalva maneuver (VM) experiment included 30 healthy volunteers who received both color Doppler imaging of the internal jugular vein and fundus photography for retinal venule diameter measurement. **RESULTS:** In the case-control study, TMB patients had a wider retinal venule diameter (184.5 +/- 17.5 vs. 174.3 +/- 16.2 microm, right eye, p = 0.023; 194.20 +/- 24.6 vs. 176.6 +/- 19.5 microm, left eye, p = 0.017), especially TMB patients with JVR. The VM experiments showed that the presence of JVR was associated with a greater increase in retinal venule diameters during VM in the subjects' right eye (14.27 +/- 11.16 vs. 2.75 +/- 3.51%, JVR vs. non-JVR, p = 0.0002) and left eye (10.06 +/- 6.42 vs. 1.80 +/- 2.03%, p = 0.0003). **CONCLUSIONS:** These findings provide evidence that frequently occurring JVR associated with TMB impedes ocular venous outflow, and the subsequent disturbances in ocular venous circulation may be a cause of TMB. (c) 2009 S. Karger AG, Basel.

<http://www.ncbi.nlm.nih.gov/pubmed/19955735>

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Vestn Rentgenol Radiol. 1999 Sep-Oct;(5):13-7.

**[The study of cerebral venous blood flow disturbance peculiarity in the norm and under the extravasal compression of brachiocephalic veins with the use of magnetic resonance venography and ultrasound duplex scanning]**

[Article in Russian]

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**Abstract**

The MR-venography of the veins and brain venous sinuses, brachiocephalic veins and internal jugular veins duplex scanning have been performed in order to study the distinctions of cerebral venous hemodynamics of healthy people and the patients with venous encephalopathy caused by the extravasal compression of the brachiocephalic veins at the neck level and the superior sections of mediastinum. It has been revealed that the blood flow reducing in transverse brain sinuses occurs not only in the case of outflow disorder in the distal sections of the venous system, but also in norm. This reducing depends on anatomic constitution of confluens sinuum and the venous angle type of brachiocephalic veins. The three venous angle types of brachiocephalic veins have been distinguished: y-type, mu-type and Y-type. It has been registered that in case of the mu-type angle the blood flow can be reduced in norm due to peripheral resistance increase at the physiological bends of nearly a right angle type. The distinctions of hemodynamics in case of venous obstruction in contrast to arterial obstruction have been described. It has been registered that in case of outflow trouble in one of the internal jugular veins the speed and the volume of the blood flow in it are progressively reduced depending on the duration and the manifestation of compression. All this results in narrowing of the vein diameter from the affected side, and in compensatory distention of the diameter and increase of blood flow volume in the contralateral internal jugular vein, vertebral and external jugular veins, in succession.

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**Retrograde jugular flow associated with idiopathic normal pressure hydrocephalus.**

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## **Abstract**

To clarify the relation between the drainage pathway of cerebrospinal fluid and the development of idiopathic normal pressure hydrocephalus (iNPH), we examined flow patterns of internal jugular veins in 20 patients with iNPH and 13 control patients using air-contrast ultrasound venography during the Valsalva maneuver. The iNPH group had a significantly greater frequency of retrograde jugular venous flow (19/20, 95%) than the control group (3/13, 23%) (chi(2) test,  $p < 0.001$ ). Our results suggest that retrograde jugular venous flow may be associated with the development of iNPH; therefore, the analysis of retrograde jugular venous flow could be a useful element in the diagnosis of iNPH.

<http://www.ncbi.nlm.nih.gov/pubmed/18570299>

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