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## Internal jugular vein valves: an assessment of prevalence, morphology and competence by Color Doppler Echography in 240 healthy subjects

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### Summary

The presence of valves in the head and neck veins is known since classical anatomical dissections. Previous studies have investigated whether jugular veins show constant valves at their ostium and whether these valves are physiologically competent, but, unluckily, these studies have reported conflicting results. Further, recent observations have raised the question whether the incompetence of jugular vein valves might play a pivotal role in neurological disorders related to venous engorgement of the brain. In this study we examined 462 internal jugular veins by using an echocolorodoppler apparatus. In particular, we assessed the presence, morphology and competence of valves at their ostium. Unilateral jugular vein valves were present in 406 cases (88%), mainly on the right side. The most frequently observed morphology (75%, 305 cases) was the two-leaflet valve, and jugular vein valves were incompetent in the huge majority of cases (365 cases, 90%). Our findings confirm the anatomical variability predicted from classical anatomical studies but, unluckily, do not provide additional evidence on the possible role of jugular vein valves in physiology and pathology. Further studies are strongly needed to determine whether these valves actually play an important role in counteracting chest venous pressure and in preventing reflux towards the brain.

### Key words

Internal jugular vein valves, echo-color-doppler.

### Introduction

Jugular vein valves are known since the seventeenth century, when Riolo first (Riolo, 1649) and Kerckring afterwards (Kerckring, 1670) consistently reported the presence of one- or two leaflet valves at the level of jugular vein ostium in the majority of their cadaveric dissections. However, subsequent studies on cadavers conducted at the beginning of the last century (Poirier and Charpy, 1903; Chiarugi, 1912) failed to consistently report the presence of jugular vein valves, particularly in the left inter-

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nal jugular vein. Thus, due to the conflicting results about their presence and their morphology, these anatomical structures have been considered for a long time as an embryological residues and their hemodynamic role has been underestimated.

In the last years jugular vein valves have been accurately studied in large sets of cadavers (Delausgiers, 1994) and the presence of jugular vein valves has appeared as a frequent finding, with the two-leaflet morphology as the most prevalent type. Furthermore, by using jugular vein catheterization these studies found that most jugular vein valves were competent. On the contrary, studies conducted by using echocolor-doppler found that most jugular vein valves were incompetent, so that jugular vein valve incompetence has been for a long time considered as a normal finding (Macchi and Catini, 1994).

Akkawi (2002) has recently suggested that the incompetence of jugular vein valves might cause cerebral venous reflux and other authors have hypothesized that their malfunction might play a substantial role in cerebral air embolism (Nedelmann, 2006), pulmonary hypertension (Doepf, 2008) and transient global amnesia (Cejas *et al.*, 2010).

Aim of this study was to make an anatomical assessment of jugular vein valves, including their presence, structural morphology and competence, and the relationships with sex, age, body weight, height, and internal jugular vein diameter at the valve level.

## Subjects and Methods

A total of 240 subjects were included in the study for an echocolor-doppler examination of internal jugular veins and their valves. All the subjects included were healthy, in particular they were free from cardiovascular diseases; a preliminary echocardiography was performed on all subjects to exclude cardiac valve stenosis or incompetence. Nine subjects were excluded from the study due to inadequate acoustic window.

The remaining 231 subjects (109 men and 122 women; age range: 21-92 years) were studied in the supine position with echocolor-doppler. We used an Acuson 128 XP Doppler ultrasonography apparatus with a 5 MHz probe. We examined jugular veins bilaterally at the ostium, observing the valve presence, gross structure and competence, and we measured the jugular vein diameter. Valve competence was assessed by asking the subjects to inflate into a cannula connected to a mercury sphygmomanometer till reaching, and maintaining for at least 5 seconds, a pressure of 20 mmHg, and observing the presence of a retrograde color jet.

As is well known, jugular veins do not have a regular, circular cross-section, and their caliber is influenced by the cardiac cycle. For these reasons we assessed the internal jugular vein diameter at the ostial level by calculating the mean value of four perimetral measurements taken in the various phases of the cardiac cycle.

## Results

Of the 462 Internal jugular veins studied, we documented a valve apparatus in 88 % of cases (N = 406) (Table 1). The remaining 12 % subjects, in whom we were not able to detect the presence of any valve, were in prevalence men: however there was

no statistically significant difference between sexes. The most common type was the two-leaflet valve, found in 305 patients (75 %), followed by the single-leaflet type in 57 patients (14%), and by the least common three-leaflet valve in 44 patients (11%) (Table 2). No statistically significant correlation was found between the number of valve leaflets and age, side, sex, height or body weight.

The average position of valve apparatus was at 28 mm distance from the jugulo-subclavian junction.

The mean diameter of the jugular vein was 13.5 mm, and was significantly larger in male than in female subjects ( $p < 0.01$ ) (Table 3). The diameter showed a tendency to increase with advancing age, however the data did not reach statistical significance (Table 4).

**Table 1** – Presence of ostial valves in the internal jugular veins.

Total cases	Presence		Absence	
462	406 (88%)		56 (12%)	
	Males	Females	Males	Females
	197	209	31	25

**Table 2** – Morphology of valvular apparatus.

Total of cases	Two Cusps		One Cusp		Three Cusps	
406	305 (75%)		57 (14%)		44 (11%)	
	Males	Females	Males	Females	Males	Females
	146	159	31	26	20	24

**Table 3** – Internal jugular vein diameter  $\pm$  standard deviation (mm).

Total (n = 462)	Males		Females	
13.5 $\pm$ 1.8	15.8 $\pm$ 1.8		12.2 $\pm$ 1.5	
	Right	Left	Males	Females
	15.5 $\pm$ 1.4	16.1 $\pm$ 1.4	11.9 $\pm$ 1.5	12.5 $\pm$ 1.5

**Table 4** – Differences in the mean diameter of internal jugular vein caliber between consecutive age classes.

Classes of Age		p
From	to	
21-30	30-42	-
42-54	54-66	0.02
66-78	78-92	0.01

**Table 5** – Valvular competence.

Total	Incontinent Valves	Continent Valves
406	365 (90%)	41 (10%)

**Table 6** – Morphology of continent valves.

Total	Two Cusps		One Cusp		Three Cusps	
41	29		10		2	
	Males	Females	Males	Females	Males	Females
	13	16	6	4	2	0

During the assessment of valve competence, reflux during inflation was observed in 90% of patients (N = 365) (Table 5). Only in 10% of cases (41 subjects) there was no reflux: of these, 21 were men and 20 women, all under the age of 20 years. The majority of competent valves were of the two-leaflet type (29 cases, 13 men and 16 women), followed by the single-leaflet type (10 cases, 6 men and 4 women), and by the three-leaflet type in 2 cases (both men) (Table 6).

## Discussion and conclusion

Anatomical textbooks normally report valves to be absent from the venous districts of neck and head (Poirier and Charpy, 1903; Chiarugi, 1912; Testut and Latarjet, 1972), assuming that they are poorly developed or regressed with evolution, because there is no need to overcome the force of gravity in the drainage process.

Our results agree with previous anatomical observations, particularly about the frequent absence of internal jugular vein valves on the left side (Lepori *et al.*, 1999; Sanchez-Hanke, 2000).

The results of pressure test on valve competence seem to lead to the conclusion that jugular vein valve incompetence represents a normal finding in healthy subject. It is otherwise known that during coughing, defecation strain, Valsalva maneuver or chest compression during resuscitation procedures, the jugular pressure increases and the cerebral venous flow can be inverted (Lurie *et al.*, 2002; Bronlow and McKinney, 1985). Many studies are trying to correlate such transitory venous flow inversion with a variety of transient cerebral effects, such as cough-induced headache (Knappertz, 1996). Recent studies are focusing on the strict association between jugular vein valve incompetence and transient global amnesia (Cejas *et al.*, 2010), supporting Lewis' hypothesis of brain venous congestion (Lewis, 1998), which would induce mesio-temporal transient ischemia.

Indeed, further studies are needed to evaluate whether there is a real increased prevalence of jugular vein valve absence or incompetence in patients with transient global amnesia or, more likely, whether the presence of at least one competent valve acts as a protective factor from cerebral venous engorgement in the case of increased chest venous pressure. Some authors suggest to concentrating on valve motion

instead of competence, being this aspect complex and various, and probably the real index of valve function (Morimoto et al., 2009).

With regard to caliber, our findings are also similar to those of previous studies (Macchi and Catini, 1994; Lepori et al., 1999; Sanchez-Hanke, 2000). The observation of a statistically significant larger caliber in male subjects is in agreement with our previous observations (Macchi and Catini, 1994) from other vascular districts, where male subjects always demonstrated a larger caliber of both venous and arterial vessels, when compared with female subjects of the same age.

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