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Assessment of internal diameters of abdominal and femoral blood vessels in 250 living subjects using Color Doppler ultrasonography

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Summary

Acquiring data about venous or arterial vessel size is important for several reasons, given the increasing incidence of thomboembolic phenomena and arterial aneurysms and the emerging new vascular techniques. We studied 250 healthy subjects (125 men and 125 women; age range: 50 to 91 years) with no known vascular pathology, nor hypertension, nor diabetes. We assessed the caliber of abdominal aorta, inferior vena cava, iliac and femoral arteries and viens by color doppler ultrasonography, and analyzed the results with regard to sex, height, weight and body surface of each subject. The mean caliber measure of the large abdominal vessels appeared lower than the value obtained from cadavers. There was a direct proportion between the left and right vessels of the same subject. The difference in vessel caliber between male and female subjects was statistically significant. There was no correlation between vessel caliber and age, height or body surface area.

Key words

Abdominal and femoral vessels, echo- color-doppler

Introduction

Acquiring data about venous or arterials vessel size is important for several reasons and purposes. The caliber of veins plays an important role in thromboembolic phenomena and the local and remote effects of those phenomena. On the other hand, the study of the anatomy of arterial districts is fundamental not only to discriminate normal from aneurismatic vessels, but also for the application of intravascular devices and for the execution of intravascular endoscopic techniques.

These observations are even more useful in practical clinic, if we focus our attention on large vessels of the lower limb and of the abdomen, given the increasing incidence of emboli originating in the abdomen and of aneurysmal dilatation of the abdominal aorta. Indeed, a femoral approach is the most used access for arterial cath-

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eterism to perform major endovascular procedures as coronarography and intraortic balloon placement.

The caliber of vessels may be influenced by anthropometrical and physiological factors. However, how factors such as sex, height, weight or body surface influence vessel calber, and what is the importance of each single factors, is still unclear.

A detailed anatomical assessment of a vascular district can be obtained using vascular ultrasonography (Macchi and Catini, 1994). This non-invasive and low cost method offers significant advantages for the study of vessels in living subjects. The accuracy of ultrasonography also exceeds that of cadaveric measurements: in fact the latter findings are biased by structural changes of collagen tissues of the vessels that occur after death.

The purpose of our study has been to assess the caliber of large vessels focusing on abdominal aorta, inferior vena cava, iliac and femoral arterial and venous vessels, using color doppler ultrasonography, and to compare and correlate the results with sex, height, weight and body surface of each subject.

Methods

We studied 250 healthy subjects (125 men and 125 women; age range: 50 to 91 years) with no known vascular pathology, nor hypertension, nor diabetes. In each patient, after informed consent, we examined the caliber of:

1. Abdominal aorta 4 cm proximal to and immediately before the bifurcation (that is, before the increase of caliber in the bifurcation);
2. Inferior vena cava, both 4 cm after its origin and immediately above the confluence of the iliac vessels, where the vein uniformly narrows;
3. Iliac vein and artery, both 20 mm after their origin and at their confluence;
4. Common femoral artery, 1 cm before the origin of deep femoral artery;
5. Superficial femoral artery, 1 cm after its origin;
6. Common femoral vein, 1 cm after its junction with the saphenous vein;
7. Superficial femoral vein.

The measurements have been taken with the patient in horizontal supine position. Arteries have been evaluated during the diastolic phase, the veins during post-inspiratory apnea. The data were analyzed with respect to age, sex, height and body weight. We performed all measurements using an Acuson 128 XP Echo-Color Doppler ultrasound system with 7 MHz probe; a Polaroid freeze frame color printer was used for documentation. The results are indicated as mean ± standard deviation.

Results

The measurements, including mean values and standard deviation for men and women and for all measurements together and the range of all measurements, are given in Table 1.

We found a statistically significant association ($p<0.01$) between increase in age and increase in the caliber of the abdominal aorta, inferior vena cava, iliac arter-

Table 1 – Mean caliber and standard deviation (mm) of the abdominal and lower limb venous and arterial vessels in men and women.

Vessel	Total (mean ± sd)	Total (range)	Men (mean ± sd)	Women (mean ± sd)
Abdominal Aorta				
Bifurcation	15.7 ± 1.8	12.5 - 18.9	16.8 ± 1.8	14.6 ± 1.7
4 cm above bifurcation	16.0 ± 1.1	12.0 - 20.0	17.4 ± 1.3	14.5 ± 1.2
Inferior Vena Cava				
Origin	17.0 ± 1.3	14.0 - 26.0	18.1 ± 1.1	15.8 ± 1.5
4 cm a.	19.9 ± 1.7	17.0 - 22.8	21.7 ± 1.5	18.0 ± 1.9
Right Iliac artery	9.2 ± 1.3	8.0 - 10.0	9.8 ± 1.2	8.6 ± 1.4
Left Iliac artery	9.2 ± 1.3	7.9 - 10.5	9.3 ± 1.4	7.6 ± 1.2
Right Iliac vein	9.5 ± 1.2	7.0 - 16.0	10.2 ± 1.2	8.7 ± 1.1
Left Iliac vein	10.0 ± 1.2	6.5 - 13.3	10.5 ± 1.3	9.4 ± 1.1
Right Common Femoral Artery	6.9 ± 0.7	6.6 - 8.4	7.4 ± 0.6	6.5 ± 0.8
Left Common Femoral Artery	6.9 ±0.6	6.5 - 8.4	7.4 ± 0.5	6.5 ± 0.7
Right Common Femoral Vein	11.0 ± 1.4	9.3 - 13.3	11.3 ± 1.3	10.7 ± 1.5
Left Common Femoral Vein	11.1 ± 1.4	9.2 - 13.6	11.4 ± 1.2	10.8 ± 1.6
Right Superficial Femoral Artery	5.2 ± 0.5	4.6 - 6.5	5.3 ± 0.5	5.0 ± 0.4
Left Superficial Femoral Artery	5.2 ± 0.5	4.5 - 6.4	5.3 ± 0.4	5.1 ± 0.5
Right Superficial Femoral Vein	9.9 ± 1.4	8.5 - 11.5	10.0 ± 1.3	9.8 ± 1.5
Left Superficial Femoral Vein	10.0 ± 1.5	8.5 - 11.4	10.1 ± 1.3	9.8 ± 1.6

ies and iliac veins. The caliber of vessels was larger in male than in female subjects ($p<0.01$). There was no significant difference in caliber between left and right vessels. There was no correlation between body weight and caliber of any vessel.

Discussion and conclusion

Interesting data have emerged from the analysis of the caliber of the large vessels of the abdomen, where we have found lower values than those derived from autoptical studies, particularly regarding the vena cava. In cadavers, the mean caliber of vena cava is larger than 20 mm, reaching values over 30 mm in Chiarugi's (1912) observations, while here the mean caliber was 19.9 mm. For abdominal aorta, our mean caliber results of at least 5 mm lower than Chiarugi's measures (Chiarugi, 1912). These data are even more interesting if we consider that our population was composed of people with a mean age of 70 years, and that vessel caliber increases with aging. A possible explanation of this discrepancy is that cadaveric vessels undergo caliber changes caused by natural fenomena that occurs after death. Moreover, anatomical studies were conducted at the beginning of the past century, and the populations studied may have had different anthropometrical characteristics.

Our results about lower limb vessels are in accord with the measurement of Gulisano et al. (1982). There were no significant differences in caliber between left and right vessels, confirming the results of our previous report about femoral blood vessels (Macchi et al., 1996). This finding suggests that if we measure the caliber of a vessel we should expect the size of the contralateral to be approximately the same.

Many individual factors as age, sex and body surface area can contribute to individual variations of lower limb vessel caliber, as for any other arterial district. However, the role of each single factor is still controversal (Simon et al., 1988; Forbes et al., 2006).

The effect of aging on arteries is well known, producing a progressive widening of the vessel due to prolonged wall stress, as observed by many authors (Macchi et al., 1996; Wolak et al., 2008; Ozdogmus, 2008). In our study, we observed a trend towards increasing caliber as age progresses, but it did not reach statistical significance. A possible explanation of this lack of significance may be the small size of the population sample studied.

The difference in vessel caliber between males and females is statistically significant, as had been reported also reported for other arterial districts. This is in agreement with our previous results (Macchi et al., 1996). Gender difference is difficult to explain only as a matter of body size. A highly significant correlation between femoral vessel caliber and body size index had been reported in a previous study on a large population (Mortensen et al., 1990). However this observation has proved to be poorly reproducible in larger populations, possibly due to the interference of other variables in determining vessels caliber. Indeed, our experience for lower limbs, as for other vascular districts, has not allowed to recognize a statistical correlation between body size and vessel caliber.

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