The use of ultrasonic tomography to measure the calibers of the iliac arteries and veins and the caliber and length of the inferior vena

IT. J. ANAT. EMBRYOL. Vol. 99, n. 3: 181-188, 1994

University of Florence, Italy
* Institute of Gerontology and Geriatric Medicine
** Department of Human Anatomy and Histology

The Use of Ultrasonic Tomography to Measure the Calibers of the Iliac Arteries and Veins and the Caliber and Length of the Inferior Vena Cava and the Abdominal Aorta

Claudio Macchi * - Claudio Catini **

Key words: caliber, abdominal vessels, ultrasonic tomography.

SUMMARY

One hundred eighty healthy subjects (90 men, 90 women; age range: 55 to 80 years) with no known cardiovascular disease were studied by ultrasonography. In each, the following measurements were obtained: the caliber and length of the abdominal aorta and inferior vena cava, and the caliber of the common iliac arteries and veins. The mean length of the inferior vena cava was found to be 95.2 mm, its mean caliber 18.4 mmm. The mean length of the aorta was 83.1 mm, and its mean caliber was 15.9 mm. The mean caliber of the common iliac veins was 9.7 mm, while that of the common iliac arteries was 8.8 mm.

There was a statistically significant relationship between vessel caliber and subject age; furthermore, the vessel caliber of the male subjects was found to be larger than that of the females by a statistically significant margin. There was also a statistically significant correlation between subject height and the length of the two major vessels; however, no statistically significant correlations were noted between the measured parameters and body weight. In comparison with the values reported in the standard textbooks and by contemporary cadaveric studies, our measurements of mean aortic and vena caval calibers were significantly lower. When the two side were compared, a statistically significant difference was noted only in the iliac arteries, where the right was larger than the left.

INTRODUCTION

Given the increasing incidence of emboli originating in the abdomen and of aneurysmal dilatation of the abdominal aorta, anatomical studies of the two major abdominal vessels, the aorta and the inferior vena cava, are imperative. Data regarding the venous diameter contributes to the study of these processes and to the prevention of embolic phenomena (which frequently originate in the lower limbs) by the placement of surgical filters (Mobin Udin et al, 1969; Riggs, 1972; Laroche, 1978; Andreassian et al, 1984; Chapuis et al, 1984). Similarly, data regarding arterial diameter is helpful in that it provides reference standards by which to distinguish normal from abnormal vessels. It is of great clinical importance to have accurate, quantitative anatomical data in living subjects in order to be able to discriminate abnormalities in a physiological setting. In this context, data regarding the relationships of these data to sex, age, height, and body weight are particularly important.

A number of classic studies (Beneke, 1878; Schiele-Wiegandt, 1880; Suter, 1897; Scheel, 1908; Chiarugi, 1912; Testut and Latarjet, 1972) and others (Le Floch-Prigent, 1989) have examined the biometrical properties of the major abdominal vessels in cadavers. Others have examined living subjects by ultrasonography (Grant et al, 1980; Lopez Maruro, 1985). The main purpose of our study is to determine the infrarenal calibers of the abdominal aorta and inferior vena cava and the calibers of the common iliac arteries and veins by means of color doppler ultrasonography through an easily explorable approach. We have compared our data with those reported by older and contemporary studies.

Apart from being noninvasive, ultrasonography has the advantage of permitting *in situ* measurements in living subjects. This approach provides a more accurate assessment than cadaveric measurements, since the findings are not influenced by the distortions that can occur in the post mortem state by changes (albeit limited on the macroscopic level) of the collagen and elastic fibers and thus the intimal structure of the vessels.

MATERIALS AND METHODS

We examined 180 healthy subjects (90 men, 90 women; age range: 55 to 80) with no known cardiovascular pathology. In each, we measured: the caliber of the abdominal aorta 4 cm proximal to and immediately before the bifurcation (that is, before the increase of caliber in the bifurcation); the caliber of the inferior vena cava, both 4 cm after its origin and at the level that corresponds to the point at which the vessel uniformly narrows following the confluence of the iliac vessels; the infrarenal extent of the two vessels (the distance between the origin of the renal vessels and the point immediately preceding the increase of caliber of the iliac

bifurcation); and the caliber of the iliac veins and arteries 20 mm from both their respective origins and their confluence.

These data were analyzed with respect to age, sex, height, and body weight.

The measurements were obtained with an Acuson 128XP color doppler ultrasound apparatus using a 2 MHz sectorial probe. Mono and 2-dimensional scansion and color codification were used. The units of measurement were millimeters and tenths of millimeters.

RESULTS

Inferior Vena Cava Measurements

The mean length was 95.2 ± 2.7 mm; the values ranged from a minimum of 58 mm to a maximum of 136 mm (*Tab. I*). Four centimeters from its origin, the mean vessel caliber was 19.9 ± 1.7 mm (range: 16 to 22 mm). the mean caliber at the origin was 17 ± 1.4 mm (range: 14 to 27 mm) (*Tab. III*).

Abdominal Aorta Measurements

The mean length was 83.1 ± 2.2 mm (range: 59 to 105 mm) (*Tab. II*). Four centimeters from the bifurcation, the mean caliber was 16 ± 1.3 mm (range: 13 to 21 mm). The mean caliber just proximal to the bifurcation was 15.8 ± 1.6 mm (range: 12 to 23.5 mm) (*Tab. IV*).

TABLE I - *The mean values (mm ± sd) of the vena cava inferior length. (Subrenalis measurement).*

Totality	Males	Females	Pt
95.2 ± 2.7	97 ± 1.8	93.2 ± 3.6	0.01

TABLE II - *The mean values (mm ± sd) of the abdominal aorta length. (Subrenalis measurement).*

Totality	Males	Females	Pt
83.1 ± 2.2	86 ± 2.3	80 ± 2.1	0.01

TABLE III - *The mean caliber (mm ± sd) of the vena cava inferior at its origin and 4 cm after.*

	Totality	Males	Females	Pt
Origin	17 ± 1.4	18.2 ± 1.3	15.8 ± 1.5	0.01
4 cm a.	19.9 ± 1.7	21.7 ± 1.5	18.1 ± 1.9	0.01
Pt	0.01	0.01	0.01	

TABLE IV - *The mean caliber (mm ± sd) of the abdominal aorta before the bifurcation and 4 cm before.*

	Totality	Males	Females	Pt
Origin	15.8 ± 1.6	16.9 ± 1.7	14.7 ± 1.5	0.01
4 cm a.	16 ± 1.3	17.5 ± 1.2	14.5 ± 1.4	0.01
Pt	ns	ns	ns	

Iliac Vein Measurements

The mean caliber of the right iliac vein was 9.5 ± 1.2 mm (range: 7 to 16 mm); that of the left iliac vein was 9.9 ± 1.3 mm (range: 6.3 to 17.3 mm) (*Tab. V*).

Iliac Artery Measurements

The mean caliber of the right iliac artery was 9.2 ± 1.3 mm (range: 6.8 to 13 mm). The caliber of the left iliac artery was 8.4 ± 1.2 mm (range: 6.9 to 12 mm) (Tab. VI).

There was a statistically significant ($p < 0.01$) correlation between age and the increase of the calibers of the abdominal aorta, iliac arteries, inferior vena cava, and iliac veins. However, no statistically significant correlation between age and the lengths of the aorta and vena cava was observed. When sex was considered, there was a statistically significant difference ($p < 0.01$) for all the vessels considered, those of the male subjects being larger than those of the females.

Subjects height was directly proportional the lengths of the aorta and vena cava; this relationship was statistically significant ($p < 0.01$). However, there was no

TABLE V - *The mean caliber (mm ± sd) of the venae iliacae 20 mm before their termination.*

	Totality	Males	Females	Pt
DX	9.5 ± 1.2	10.3 ± 1.1	8.8 ± 1.1	0.01
SN	9.9 ± 1.3	10.5 ± 1.4	9.4 ± 1.2	0.01
Pt	ns	ns	ns	

TABLE VI - *The mean caliber (mm ± sd) the arteriae iliacae 20 mm after their origin.*

	Totality	Males	Females	Pt
DX	9.2 ± 1.3	9.9 ± 1.3	8.5 ± 1.3	0.01
SN	8.4 ± 1.2	9.2 ± 1.4	7.6 ± 1.1	0.01
Pt	0.01	0.01	0.01	

correlation between height and vessel caliber. Furthermore, there was no correlation between body weight and the vessel characteristics measured.

When the two sides were compared, there was a statistically significant difference between the two iliac arteries, the right being larger than the left ($p < 0.01$). Regarding the two measurements performed in the aorta and vena cava, the difference in values was observed to be statistically significant ($p < 0.01$) only in the vena cava, in which the caliber at 4 mm from the origin was larger than that at the origin.

CONCLUSIONS AND DISCUSSION

The most interesting finding to emerge from this study is the significant difference between our ultrasonographic measurements of caliber and those reported by other investigators in cadavers. Our values were much lower, particularly in the inferior vena cava. Indeed, while our mean caliber (mean of the measurements at the two different sites) was 18.4 mm, Chiarugi (1912) found a caliber of 33 mm, Testut and Latarjet (1972) 28 mm, and Le Floch-Prigent (1989) 23.85 mm.

The abdominal aortic caliber of 15.9 mm that we obtained correlated well with the values of Muratori and Gotte (1950), who have reported a lower caliber of 12.4 mm. However, it differed considerably from those reported by Chiarugi (1912), 19 mm; Testut and Latarjet (1972), who have reported a caliber of 20 mm; and Le Floch-Prigent (1989), who have reported a caliber of 20.8 mm. In contrast, our values for the other parameters generally agree with those of both the older and contemporary reports.

The significant difference between the calibers reported by us and by the above-mentioned investigators is even more interesting when one considers that the mean age of the subjects of our case series is relatively high (68 years) and that vessel caliber increases with age. Nonetheless, this is consistent with previous studies we have performed with the same methodology in the supraaortic trunks (Macchi, et al., 1993) and aortic arch (Macchi and Catini, 1993) of living subjects. In these studies, our values again differed significantly from those reported by both older and contemporary cadaveric studies. This may be explained by changes in cadaveric tissues that are caused by natural phenomena and preparation methods, as well as by differences in the population and their age. Furthermore, it must not be forgotten that not only were many of the classic studies performed on a limited number of subjects, they were done up to 100 years ago, when the study populations may have had very different characteristics.

From our study, we may draw some interesting conclusions. The difference of caliber in different segments of the vena cava suggests that caution should be exercised in measuring the vessel, especially when the placement of a surgical filter is planned. The caliber of the abdominal aorta, which can range up to 22 mm, allows us to speak of aneurysms for values over 2.5 mm.

Arrived 15/1/94. Accepted 20/2/94.

REFERENCES

Andreassian B, Cohen G, Duchatelle JP, Kitzis M, Chalaux G, Parot A, Richer De Forges M. 1984 Méthodes, résultats et indications de l'interruption de la veine cave inférieure. Chirurgie 110, 472-480.

Beneke FW. 1878 Die anatomische grundlagen derconstitutionsanomalien des Menschen Marburg NG Elwert'sche Verlagsbuchandlung.

Chapuis Y, Bonnichon P, Zerbig M, Pinto. 1984 Interruption partielle du courant cave inférieur: clip ou ombrelle? Chirurgie 110, 309-312.

Chiarugi G. 1912 istituzioni di Anatomia dell'Uomo. SEL, Milano, vol II, 77.

Chiarugi G. 1912 Istituzioni di Anatomia dell'Uomo. SEL, Milano vol II, 341.

Grant E, Rendano F, Sevinc E, Gammelgaard J, Holm HH, Gronvall S. 1980 Normal inferior vena cava; caliber changes observed by dinamic ultrasound. Amer J Radiol, 135, 335-338.

Laroche JP. 1978 Interruption partielle de la veine cave inférieure par clipe-cave et filtre-ombrelle (à propos de 110 cas). Thèse de médecine, Grenoble, n° 45, 95-661.

Lopez Maruro EN. 1985 normal dimensions determined by ultrasound for the gallbladder and the suprahepatic, splenic, inferior vena cava and portal veins in the child. Bull Med Hosp Inf Mex, 42, 3379-3383.

Macchi C, Giannelli F and Catini C. 1993 The measurement of the caliber of the branches of the aortic arch: a statistical investigation of 430 living subjects using ultrasonic tomography. It J Anat Embryol, 98, 2, 69-79.

Macchi C. 1993 The measurements of the dimensions of the human aortic ring using echocardiography: anatomical correlations and statistical investigation of 219 living subjects. It J Anat Embryol, 98, in print.

Mobin Udin K, Mac Lean R, Bolooki H, Jude JR, Gables C. 1969 Caval interruption for prevention of pulmonary embolism Arch Surg 99, 711-715.

Muratori G, Gotte L. 1950 Il perimetro e lo spessore della aorta discendente e di alcune sue collaterali viscerali (arterie celiaca, mesenterica superiore, renale) in rapporto all'età, al sesso ed alla costituzione. Archivio di Anatomia, LV, 3-4, 269-305.

Riggs OE. 1972 Vena cavography relative to umbrella filter placement. Radiology 105, 450-451.

Scheel O. 1908 Gefassmessungen und Arteriosklerose. Virchow's Archiv, 191, p 135.

Schiele-Wiegandt V. 1880 Ueber Wanddicke und umfang der arterien des menschlichen korpers. Virchow's Archiv, Bd 82, p 27.

Suter F. 1897 Ueber das verhalten des aorten umfanges unter phisiologischen und patologischen bedingungen. Arch Exp Path und Phis, Bd 39, p 289.

Testut L, Laterjet A. 1972 Trattato di Anatomia Umana. UTET, Torino, III, 962-966.

Testut L, Letarjet A. 1972 Trattato di Anatomia Umana. UTET, Torino, III, 688-692.

Address:
Prof. Claudio Catini
Dipartimento di Anatomia
Umana e Istologia
Policlinico di Careggi
50134 Firenze - Italy