Internal diameters of human femoral blood vessels in 50 healthy subjects using color Doppler ultrasonography.

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Internal diameters of human femoral blood vessels in 50 healthy subjects using color doppler ultrasonography

Claudio Macchi */** - Leonardo Corcos ** - Francesca Cecchi *****
Fabrizio Giannelli * - Francesco Repice * and Gherardo Gheri *

* Department of Human Anatomy and Histology, University of Study of Florence, Italy
** Department of Surgery, University of Study of Sassari, Italy
*** "Fraticini" Hospital, INRCA, Florence, Italy
**** Pro-Juventute Foundation Don C. Gnocchi, Pozzolatico, Florence, Italy.

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SUMMARY

50 healthy subjects (25 men and 25 women; age range: 18 to 80 years) have been examined. The internal calibers of the common femoral artery, of the superficial femoral artery, of the common femoral vein, and of the superficial femoral vein have been measured in selected locations using Color Doppler Ultrasonography.

The difference in vessel caliber between men and women was statistically significant ($p<0.01$). There was no significant difference in left versus right vessel calibers for all the four vessels studied. In the same subject, vessel caliber was directly proportional in the left compared to the right side ($p<0.01$). Both in the left and in the right side, arterial and venous calibers of the same subject in the same side were directly proportional ($p<0.01$).

The relationship between the calibers of the four vessels under study and age, height, and body surface area were not statistically significant.

INTRODUCTION

The anatomic characterization of femoral blood vessels has great clinical value. The femoral arteries are subject to intense hemodynamic stress, and therefore present a high incidence of pathology (Klingerhofer and Meyer, 1962; Granata *et al.*, 1966; Macchi *et al.*, 1994). With the increasing use of intravascular devices, this area has gained even more interest: actually, femoral vessels are a readily available

vascular access to chatheters, cannulae, intraaortic balloon or the intravascular blood exchange devices (Mortensen *et al.*, 1987). For this reasons, a detailed anatomical characterization of this district is necessary. Further, it has recently been suggested that there is a correlation between femoral vessel caliber anc characteristics of the subject such as age, sex, height, weight, and body surface area (Mortensen *et al.*, 1990). These Authors have actually proposed nomograms which, for given individual charachteristics, provide the clinician with the expected vessel caliber.

Altogether, the literature about femoral blood vessels is sparse (Adachi, 1928; Ciardi-Dupré, 1938; Sanders, 1963; Cronier *et al.*, 1980; Mortensen *et al.*, 1990; Macchi *et al.*, 1994). Most earlier reports are based on cadaveric studies, which have been shown to carry methodologic biases due to post-mortem structural and morphological changes in tissues and to fixing and measuring procedures (Orlandini, 1968; Pacini, 1977). Arteriography has been proposed as a fairly accurate method of measuring vessel caliber, but it is cruent, expensive, and subject to methodological bias as well (Zamir, 1981). Also very expensive are other techniques, such as angio-NMR.

Some recent reports suggest that Doppler ultrasonography studies in living subjects may at least partially overcome these drawbacks vessel caliber by a reproducible, non-invasive, low-cost technique with an accuracy of tenths of millimeters (Dauzat *et al.*, 1986; Hennerici and Neuerburg, 1991; Macchi *et al.*, 1994). For this reason, Color Doppler techniques have increasingly been used for descriptive analysis of vascular anatomy (Mortensen *et al.*, 1990; Macchi *et al.*, 1993; Macchi *et al.*, 1994).

The purpose of this study was to determine the caliber of selected femoral vessels in living healthy subjects, and to verify the correlation between vessel calibers and other characteristics of the subjects. The internal calibers of the common femoral artery, of the superficial femoral artery, of the common femoral vein, and of the superficial femoral vein have been measured in selected locations using Color Doppler Ultrasonography. Vessel calibers in each person have been compared and correlated with the subject's sex, age and body surface area.

MATERIAL AND METHODS

We have examined 50 healthy subjects (25 men and 25 women; age range: 18 to 80 years: see *table 1*). The subjects were selected from patients who had been referred to us and were found free of vascular pathology, hypertension, diabetes. All the subjects gave their informed consent to participate in the study.

Using Color Doppler ultrasonography, we have measured the internal caliber of the following vessels (see *table 1*):

1) common femoral artery (CFA), 1 cm before the origin of the deep femoral artery;

TABLE 1 - *Data of all subjects considered. B.S.I.: body surface area; sfv: superficial femoral vein; cfv: common femoral vein; cfa: common femoral artery; sfa: superficial femoral artery.*

Table 1. PERIPHERAL VESSELS												
	sex	age	weight	height	B.S.I.	right sfv	left sfv	right cfv	left cfv	right cfa	left cfa	right sfa	left sfa
1	M	20	64,2	172	1,76	8	8,1	8,8	9	6,9	7	4,7	4,8
2	M	21	58,4	163	1,63	8,2	8	8,9	8,9	6,7	6,8	4,6	4,7
3	M	21	75,6	178	1,93	7,7	7,8	8,6	8,7	7,8	7,6	5	5,2
4	M	23	78	181	1,98	11	11	12,6	12,5	7,3	7,2	5	4,9
5	M	23	63,9	165	1,70	10,5	10,3	11,4	11,5	8,3	7,7	4,8	4,8
6	M	24	83,6	185	2,07	11,4	11,5	12,6	12,6	7,2	7	4,6	4,2
7	M	24	77,4	178	1,95	10,3	10,4	11,6	11,5	7,4	7,3	5,5	5,4
8	M	26	72,3	175	1,87	9,6	9,5	11,3	11,2	8,2	8,2	5,8	5,8
9	M	29	75	177	1,92	10	10	10,9	10,8	8,3	7,7	6	6
10	M	33	76,1	180	1,95	9,7	9,6	10,8	10,9	8	8	5,7	5,8
11	M	35	84	179	2,03	10,2	10,1	11,4	11,2	7,2	7,1	4,9	4,7
12	M	37	72,3	173	1,86	7,8	7,7	10,3	10,4	7	7,1	4,7	4,8
13	M	40	68,2	159	1,71	8,8	8,8	9,6	9,9	6,8	6,9	5,1	5
14	M	41	74,6	178	1,92	9,1	8,9	10,4	10,3	6,6	6,9	5,3	5,4
15	M	42	73	189	1,99	10,2	10,2	13,1	12,7	7,5	7,3	5	4,9
16	M	48	77,2	173	1,91	9,8	9,7	12	12	7,3	7,3	5,1	5
17	M	53	58,4	163	1,63	9,6	9,8	11,4	11,5	7,7	7,7	5,3	5,4
18	M	54	77,3	178	1,95	10,4	10,3	11,9	11,7	7,3	7,5	6,1	6
19	M	64	56,4	166	1,62	11,2	11,3	12,7	12,7	7,9	7,5	5,8	5,7
20	M	65	57,1	158	1,57	12,7	12,6	13,3	13,2	8,4	8,2	5,9	6
21	M	67	77	176	1,93	10,1	10,2	13	12,9	6,4	6,5	5,3	5,4
22	M	68	80,2	174	1,95	9,9	9,9	10,4	10,3	8	7,9	5,7	5,9
23	M	75	95,3	184	2,19	10,7	10,6	12,1	12,3	7,3	7,4	5,5	5,6
24	M	76	85,5	178	2,04	11,4	11,3	12	12	7	7	4,9	5,2
25	M	78	74,2	164	1,81	12,9	12,7	13	13,1	7,8	7,9	5,6	5,7
mean		43,48	73,41	173,84	1,88	10,05	10,01	11,36	11,35	7,45	7,39	5,28	5,29
SD ±		19,81	9,56	8,22	0,16	1,34	1,33	1,38	1,32	0,57	0,45	0,46	0,50
26	F	21	56,4	163	1,60	7,1	7	7,6	7,5	5,9	6	5	4,9
27	F	23	47,2	155	1,43	6,8	6,8	8,2	8,1	5,3	5	4	3,9
28	F	25	64	168	1,73	8,6	8,6	9	8,9	5,9	5,9	4,3	4,5
29	F	25	57,4	163	1,61	8,4	8,4	8,9	8,8	7	6,9	5,5	5,5
30	F	29	58,3	165	1,64	7,9	8	8	9	6,3	6,4	4,9	5
31	F	32	62	160	1,64	10	10,7	11	11,2	6,8	6,7	4,8	4,7
32	F	35	54,4	150	1,48	9,3	9,4	10,1	10	6,2	6,5	4,6	4,4
33	F	36	66,3	157	1,67	9,8	9,6	10,5	10,3	6,2	6,2	5,2	5,3
34	F	41	65	170	1,75	8,4	8,5	9,4	9,5	5,2	5	4	4,1
35	F	42	57,4	164	1,62	9,6	9,5	10,6	10,7	6,5	6,4	4,9	5,2
36	F	45	83,8	168	1,94	10,8	10,9	11,5	11,4	6,4	6,3	5	5
37	F	49	63,7	170	1,74	10	10,1	9,8	9,7	7	6,9	5,1	5
38	F	53	68,3	159	1,71	11	11,1	11,6	11,5	7	7	5,3	5
39	F	56	66,7	164	1,73	9,9	10	10,5	10,4	6,3	6,3	4,7	4,8
40	F	58	58	163	1,62	12,7	12,3	13	13	6,2	6	4,5	4,5
41	F	60	68,5	159	1,71	11,4	11	12,5	12,6	6,3	6,4	4,7	4,6
42	F	65	49,8	161	1,51	11	11	11,9	12,2	7,7	8	5,8	5,6
43	F	65	88,3	175	2,04	12,7	12,6	13	13,1	6,7	6,5	5,3	5,2
44	F	66	57,2	164	1,62	12,6	12,5	13,4	13,2	6,8	6,8	5,2	5
45	F	68	75,2	166	1,83	10	10,2	10,8	10,9	6,5	6,6	5	4,9
46	F	69	80	173	1,94	9,7	9,7	10,5	10,4	6,8	6,6	5,4	5,3
47	F	73	79,3	164	1,86	10,6	10,9	12,9	13	8,5	8,6	6,3	6,2
48	F	75	67,6	159	1,70	11,4	11,4	12,7	12,6	6,8	6,6	5,4	5,5
49	F	79	57	158	1,57	11,4	11,5	12,6	12,5	6,7	6,8	5,3	5,2
50	F	80	73,2	163	1,79	7,6	7,7	9,6	9,6	8,3	8,2	5,8	6
mean		50,80	65,00	163,24	1,70	9,95	9,98	10,78	10,80	6,61	6,58	5,04	5,01
SD ±		18,99	10,43	5,64	0,14	1,67	1,63	1,71	1,68	0,76	0,81	0,54	0,53

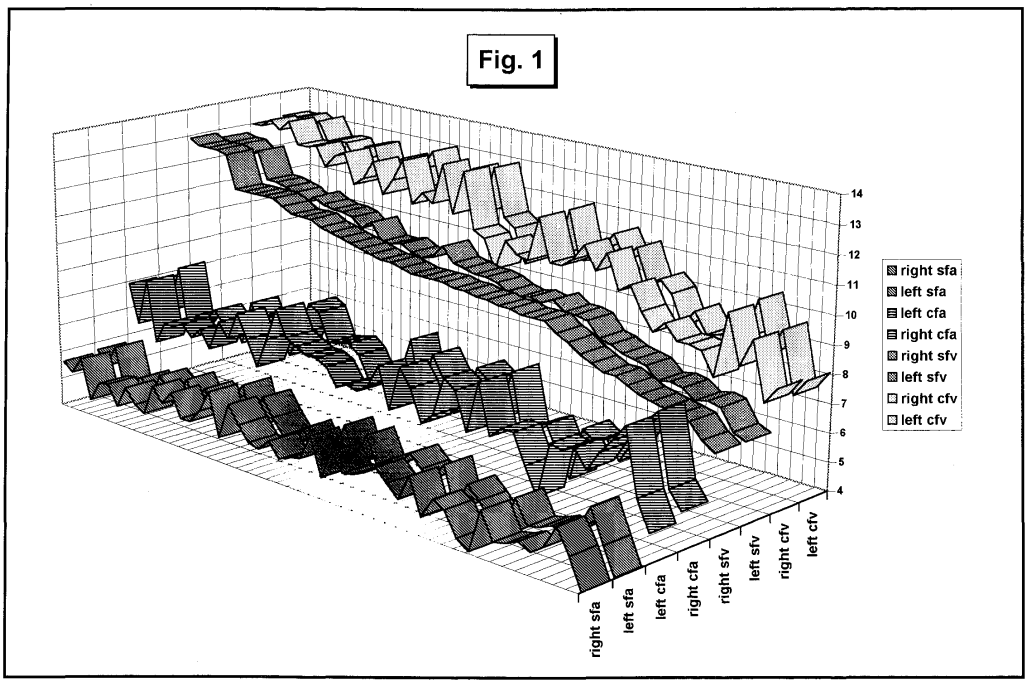

Fig. 1 — Graphical representation of all vessel considered (in mm). For abbreviation see table I.

2) superficial artery (SFA), 1 cm after its origin;

3) common femoral vein (CFV), 1 cm after its junction with the saphenous vein;

4) superficial femoral vein (SFV), 2 cm before its junction with the saphenous vein.

All measurements have been taken with the subject in a horizontal supine position: the arteries have been measured during diastole, the veins during post-inspiratory apnea. Ultrasonographic data have been correlated with sex, body surface area, and age, using the Correlation Coefficient; the significance of the "r" coefficient has been calculated using Student's T-test; vessel calibers with regard to side (right vs left) have been compared using paired Student's T-test.

Statistical analysis has been carried out both on the whole sample and separately for men and women. An Acuson 128 XP Echo-Color-Doppler ultrasound system with a 7MHz probe was used to measure vessel calibers; a Polaroid mod. freeze frame color printer was used for documentation.

RESULTS

The characteristics of the study population (sex, age, body surface area, femoral vessel calibers) are shown in *Table 1.*

In men, the mean calibers (in mm.) were the following: CFA: right = 7.45 left = 7.39; SFA: right = 5.28 left = 5.29; CFV: right = 11.36 left = 11.35; SFV right = 10.05 left = 10.01.

In women, the mean calibers (in mm.) were the following: CFA: right = 6.61 left = 6.58; SFA: right = 5.04 left = 5.01; CFV: right = 10.78 left = 10.80; SFV right = 9.95 left = 9.98.

The difference in vessel caliber between men and women was statistically significant ($p<0.01$). There was no significant difference in left versus right vessel calibers for all the four vessels studied, neither in men nor in women. Actually, in the same subjects, vessel caliber for each of the four vessels considered was directly proportional in the left compared to the right side ($p<0.01$). Also comparing arterial and venous calibers of the same subject for both left and right side, there was a direct proportion ($p<0.01$). The relationship between the calibers of the four vessels under study and age, height, and body surface were not statistically significant ($p=ns$).

DISCUSSION AND CONCLUSIONS

The mean calibers of the vessels studied are in accord with the results of Gulisano *et al.* (1982), obtained by cadavers, as well as with recent ultrasonographic data (Mortensen *et al.*, 1990; Macchi *et al.*, 1994).

The direct proportion between left and right vessel caliber, and between arteries and veins of the same side, is one of the most interesting findings, suggesting that given the caliber of one femoral vessels in one side, the expected caliber of the same vessel on the contralateral side should be approximately the same.

The absence of a significant difference between left and right vessel calibers contradicts our previous findings on the arteries of the lower limb (Macchi *et al.*, 1994), where greater calibers for the right arteries are consistently reported; this right prevalence has also been reported for other arterial and venous districts in many cadaveric and ultrasonographic studies (Bazaral and Harlan, 1981; Gulisano *et al.*, 1982; Jasinski and Rubin, 1984; Dresser and McKinney, 1987; Macchi *et al.*, 1993).

The relationship between vessel calibers and individual characteristics of the subjects such as age, sex, body surface area has been recently studied for femoral as well as for other arterial districts, but the results are highly controversial.

As to age, we found non significant correlation with the mean calibers of any of the four vessels under study. Instead, many workers have reported a significant increase with age in some arterial districts (Orlandini, 1970; Gulisano *et al.*, 1982; Macchi and Cantini, 1994), which was confirmed in our previous report on the arteries of the lower limb (Macchi *et al.*, 1994). In this study, there is a tendency of the values to increase with age which does not reach significance; this may be due to the comparatively smaller of subjects studied.

The statistically significant of vessel calibers between men and women is in accord with our previous findings on the arteries of the lower limb (Macchi *et al.*, 1994) as well of in other arterial districts (Macchi *et al.*, 1995); these findings are though in contradiction with the reports of other workers (Orlandini, 1978; Gulisano, 1982).

The gender difference is difficult to explain, since it cannot be explained with a difference in body size. In fact, the absence of correlation between vessel caliber and body surface area confirms our previous findings on the arteries of the lower limb (Macchi *et al.*, 1994) as well as on other vascular districts (Macchi, 1995). These results completely disagree with that of Mortensen *et al.* (1990), who reported correlations between femoral vessel calibers and body size indices, so highly significant to allow them to draw nomograms of the expected vessel caliber from body size parameters. As in slightly larger number of cases we could not replicate this findings, it may be inferred that such correlations cannot be extended tout-court to the general population, and that nomograms based on body size data, as appealing as they may seem, can in fact be very misleading. Further research carried on with much larger sample is needed to verify the hypotesis that a single body size parameter, or more parameters combined together can reliably predict vessel caliber in a given subject.

Our findings, obtained in the living subject by means of a reproducible, non-invasive, low-cost technique, have shown a direct proportion of femoral vessel

calibers between the left and the right side. Arterial and venous calibers of the same side are also directly proportional. As no correlation was found between vessel caliber and body size, our results generate strong doubts on whether normative tables that calculate femoral vessel caliber from body size data, as proposed by some Authors, may be actually reliable.

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Address:
Gherardo Gheri
Dipartimento di anatomia Umana Normale
e Istologia
Policlinico di Careggi
50134, Firenze, Italia