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Superficial venous anastomosis in the human upper extremity — a post-mortem study

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The frequent use of veins in surgery, especially in the replacement of clogged arteries in the lower extremities, persuaded the authors to conduct research concerning the morphology of superficial veins in the human upper extremity. In a post-mortem study a group of 40 male subjects of 22–92 years of age was examined. The preparation of the region of the elbow fossa was performed in order to establish the architecture of superficial veins in the extremity. Many detailed anthropometrical measurements were also carried out, enabling a typological evaluation to be made of the deceased under study. Two characteristic pictures of venous anastomosis were tested, one with symmetrical tributaries to the vena basilica et cephalica and the second characterised by a rich set of tributaries to the vena basilica. The characteristics, calibre and structure of both these suggest a fruitful application of them in vessel surgery. The vena cephalica in particular, taken with efficient valves, may successfully play the role of vessel implant.

key words: veins, upper extremity, morphology, preparations, vessel surgery

INTRODUCTION

The outflow of blood from the upper extremity is mainly conducted through two superficial veins, the vena basilica and the vena cephalica. These two veins differ considerably in localisation, calibre, type of tributary as well as mutual connections, especially in the elbow region where many variants can be distinguished. According to T.Marciniak the name *vena cephalica* could be derived from the names introduced to anatomy by Avicenna and then translated from Arabian to Greek: "kefalikos — belonging to the head". Also the name *vena basilica* is derived from translation into Greek of the previous Arabian name. Formerly, as can be found in ancient documents, these veins were used in blood-letting for different diseases. From the cephalic vein the blood was let in the event of headache or inflammation of the organ of vision, while from the basilic the blood-letting was used in the event of liver or spleen diseases [11].

Currently both veins are utilised in various medical procedures. In transplantations they are especially useful when the veins of lower limbs are pathologically altered, as in varicosis and thrombosis [1, 5, 13, 16]. Detailed study of the morphology of the vessels under consideration is therefore particularly important in the prophylaxis and treatment of diseases of the upper limb, especially lymphodoema.

Near the elbow fossa both superficial veins form anastomoses, which are similar in their shape to the

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letters M, Y or N. Many authors have attempted to classify these connections, such as Kadyi, Pikikiewa, Bardeleben, Gegenbauer, Testu, Potrier and Charpy, Lanz and Waschsmuth, Kadanoff, Èuèkov, Zrinow 1966 [2]. Despite the number of studies concerning the variety of superficial veins, many questions still remain unanswered regarding venous connections in the human upper extremity in the elbow fossa.

The importance of research into the build and morphology of the veins in the lower limbs perhaps underlines the fact that in many clinics the transplantation of healthy vein segments with efficient valves from an upper limb to the lower one is commonly used [3] (Fig. 1).

The methodology of examination of the morphology of the venous system in the human upper extremity is a difficult task. Measurements taken *in vivo* might be erroneous due to the subjective opinion of an investigator. Also the unambiguous determination of the venous anastomosis is very difficult because of the slight convexity of superficial venous vessels. This concerns, of course, not the large vessels but only additional ones and their tributaries. Post-mortem studies can deliver much reliable information, yet carrying them out presents difficulties concerning both the receiving of material and the free hand in preparation. Although these difficulties may extend the duration of the investigations, reliable data can only be obtained from autopsy.

The objective of the study presented is analysis of the types of venous connections near the elbow fossa as established in post-mortem studies.

MATERIAL AND METHODS

Autopsies were carried out in the Department of Pathological Anatomy of the Medical Academy of Wrocław in the years 1997–2001. 40 male subjects of 22–92 years of age were examined. The deceased under study had been patients of Wrocław hospitals and clinics. The reasons for decease were diseases of the cardiovascular or nervous systems.

In order to establish the type of anastomosis of the basilic and cephalic veins in all cases, the preparation of the region of the elbow fossa was performed in the right and left upper extremity and then photographs were taken. Additional documentation consisted of graphs and schemes of the morphological patterns of veins. According to the anatomical scheme observed, a particular venous anastomosis was marked as M, N or Y type. In cases where the type was difficult to establish, the mark I was used.

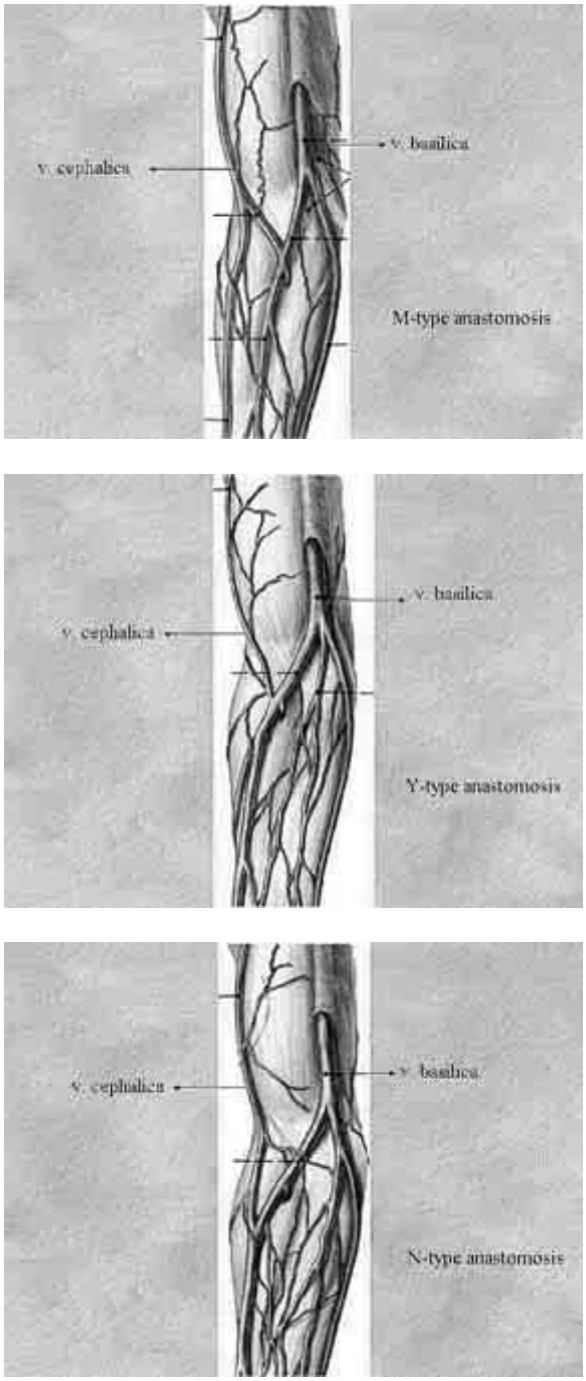

Figure 1. Schemes of M, N and Y types of anastomosis (according to Sobotta).

Detailed anthropometrical measurements were carried out in order to describe the body structure and the type of build of the deceased under study. The following measurements were taken: the length of the neck, head, trunk, thigh, shank, lower extremity, arm and forearm, the height of the body and the width of the shoulder, chest, hip, humerus epiphysis, forearm, femoral bone and epiphysis distal

of the shank. Several quotient indices were also calculated: the length of trunk index, shoulder width *vs.* body height, pelvis width *vs.* body height, length of arm index, length of forearm index, arm *vs.* forearm, length of lower extremity index, length of shank index, width of shoulder index, width of pelvis index and hip width *vs.* shoulder width.

The data obtained were then analysed statistically. The basic statistical methods were applied. Mean values, standard deviations and a coefficient of variation were calculated to describe the material, and the t-Student test was used in the comparisons.

RESULTS

The average age of the individuals under study was 62 years and ranged from 22 to 92 years. The majority of the deceased had previously been patients of the neurological, haematological and angiological units in Wrocław hospitals and clinics. The mean body height (measurement was taken after death, which causes some error due to the characteristic changes in the body after decease) equalled 170.82 cm, with a minimum value of 154.40 cm and a maximum of 186.50 cm. In Tables 1 and 2 detailed results are presented of the statistical analysis of the whole group investigated (Table 1, 2).

Table 1. Basic statistical parameters of male group under consideration (n = 40)

Trait	Mean	s	v	Min	Max
Age	61.98	16.66	18.11	22.00	92.00
Body heigth	170.86	7.26	3.89	154.40	186.50
sst-v	30.95	1.86	5.25	26.80	35.50
sst-sy	51.67	2.98	5.15	45.50	57.80
sy-ti	44.76	2.45	5.01	38.80	48.90
ti-sph	38.99	2.12	4.89	34.10	43.40
b-sy	89.67	4.76	4.83	77.30	98.60
a-r	34.92	1.65	4.36	31.10	37.90
r-sty	25.44	1.53	5.35	21.10	28.50
a-a	35.60	2.51	5.75	30.60	43.70
thl-thl	30.36	2.00	5.86	27.20	34.20
ic-ic	29.17	2.01	5.84	24.10	34.50
cl-cm	7.33	0.51	6.04	6.20	8.40
Forearm width	6.00	0.37	5.51	5.10	6.80
Thigh width	10.42	0.87	6.96	8.50	12.50
mlt-mlf	7.20	0.42	5.20	6.10	8.10

Table 2. Basic statistical parameters of quotient indices in male group under consideration (n = 40)

Trait	Mean	s	v	Min	Max
Ength of trunk	30.25	1.29	4.02	26.75	32.13
Shoulders – b.height	20.83	1.17	4.86	18.34	24.01
B.height – pelvis	17.08	1.08	5.65	14.53	19.07
Length of arm	20.45	0.73	3.31	18.78	21.93
Length of forearm	14.89	0.61	3.83	13.23	16.04
Arm – forearm	72.87	3.06	3.85	61.88	79.39
Length of lower limb	52.47	1.35	2.44	49.16	55.13
Length of shank	22.82	0.67	2.76	21.07	24.40
Width of shoulders	69.00	4.73	5.92	61.40	79.92
Width of pelvis	56.58	4.30	6.56	46.43	65.54
Pelvis – shoulders	82.07	4.38	4.72	73.35	92.90

The frequency of appearance of certain types of venous anastomosis was as follows: M = 30%, N = 45%, Y = 17.5% and I = 7.5% in right upper limb, while in left upper limb these percentages were slightly different and were equal to M = 35%, N = 42.5%, Y = 15% and I = 7.5%. The venous connection of the N-type was most frequent in both upper limbs in the whole group under consideration (Table 3–5)

It follows from the statistical data concerning the right upper limb that individuals with venous anastomosis of the N-type are more often characterised by greater values of the measured traits. Although the differences observed were not statistically significant, the data distinctly show this phenomenon (cf. Table 4, 5).

A similar observation was made regarding the left upper limb. Anthropometrical data in individuals with the N-type of venous anastomosis have greater values in comparison with the groups of the N or Y type of venous connections (cf. Table 6, 7).

Similarly frequent in occurrence were the connections of NN or MM types. The first was observed in 11 cases and the second in 10 cases. This time the means of the majority of anthropometrical data also show greater values in individuals with venous anastomosis near the elbow fossa of the type NN. Statistically significant differences were found in sst-v, sy-ti and elbow width (cl-cm) (cf. Table 8, 9).

Table 3. Frequencies of the appearance of different venous sets

Venous set in right extremity	Venous set in left extremity									
	M		N		Y		I		Total	
	n	%	n	%	n	%	n	%	n	%
M	10	25.00	1	2.50	0	0.00	1	2.50	12	30.00
N	3	7.50	11	27.50	4	10.00	0	0.00	18	45.00
Y	1	2.50	4	10.00	1	2.50	1	2.50	7	17.50
I	0	0.00	1	2.50	1	2.50	1	2.50	3	7.50
Total	14	35.00	17	42.50	6	15.00	3	7.50	40	

Table 4. Statistical description of the morphology of individual types of venous anastomosis in right upper extremity

Trait	Types of venous anastomosis in right upper extremity											
	M (n = 12)			N (n = 18)			Y (n = 7)			I (n = 3)		
	x	s	v	x	s	v	x	s	v	x	s	v
Age	60.08	10.35	17.23	60.50	18.66	30.84	61.29	20.77	33.88	80.00	6.25	7.81
Body heigth	168.65	5.89	3.49	172.77	6.99	4.05	169.16	10.06	5.95	172.17	6.55	3.81
sst-v	30.74	1.56	5.07	31.47	1.91	6.08	30.30	1.89	6.25	30.10	2.70	8.97
sst-sy	51.37	2.40	4.67	51.56	3.56	6.91	52.10	2.93	5.62	52.50	2.30	4.38
sy-ti	43.78	2.13	4.87	45.69	2.18	4.78	44.14	3.39	7.67	44.50	1.50	3.37
ti-sph	38.52	2.20	5.72	39.14	1.71	4.36	38.89	3.05	7.85	40.27	2.12	5.26
b-sy	87.56	4.02	4.59	91.14	3.82	4.19	88.54	7.09	8.01	91.87	4.41	4.80
a-r	34.42	1.05	3.06	35.41	1.52	4.30	34.00	2.35	6.91	36.17	1.37	3.77
r-sty	24.92	1.08	4.34	25.81	1.58	6.11	25.07	1.93	7.69	26.20	1.57	6.00
a-a	34.83	2.24	6.44	35.81	1.86	5.20	35.87	4.28	11.93	36.73	2.22	6.04
thl-thl	30.20	2.14	7.07	30.23	1.65	5.45	31.34	2.56	8.17	29.47	2.37	8.04
ic-ic	28.41	1.65	5.80	29.18	1.54	5.27	29.86	3.27	10.95	30.57	1.98	6.46
cl-cm	6.93	0.41	5.91	7.43	0.41	5.54	7.61	0.63	8.29	7.63	0.12	1.51
Forearm width	5.91	0.42	7.09	5.98	0.32	5.42	6.00	0.36	5.93	6.47	0.35	5.43
Thigh width	10.33	1.09	10.51	10.33	0.53	5.15	10.80	1.32	12.19	10.40	0.17	1.66
mlt-mlf	7.08	0.38	5.34	7.23	0.36	4.95	7.14	0.59	8.24	7.60	0.46	6.03

DISCUSSION

As follows from the analysis of anthropometrical indices, the group of dead males under investigation were characterised by narrow shoulders, an average pelvis and somewhat female proportions according to the classification by Wanke for male individuals (Malinowski A., Bożilov W. 1997). The parameters for length of the upper limbs showed the so called long-arm type with a short forearm, while the value of the length index of the lower extremity suggests the short-leg type with a medium shank (Table 2).

The body proportions of individuals with symmetrical venous anastomoses MM and NN were similar, with little domination of length values in individuals with the NN type of venous anastomosis (Table 9). This fact may suggest that individuals with greater length parameters of the limbs and trunk have mainly N-type venous anastomosis, while the remaining two types of venous connections (M and Y) characterise individuals with a strong body build and with an average length of limbs. Type Y in particular is often ascribed to athletic individuals, as has been shown, for example, in studies curried out among athletes and individuals whose work causes a great load on the upper limbs [2, 5, 8, 9].

Table 5. Statistical description of the morphology of individual types of venous anastomosis in right upper extremity framed in the quotient indices

Index	Types of venous anastomosis in right upper extremity											
	M (n = 12)			N (n = 18)			Y (n = 7)			I (n = 3)		
	x	s	v	x	s	v	x	s	v	x	s	v
Length of trunk	30.46	1.02	3.34	29.84	1.50	5.02	30.82	1.03	3.35	30.51	1.21	3.95
Shoulders – b.height	20.64	0.88	4.24	20.75	1.16	5.61	21.18	1.78	8.39	21.33	0.55	2.56
B.height – pelvis	16.85	0.89	5.28	16.92	1.17	6.94	17.62	1.17	6.64	17.74	0.49	2.78
Length of arm	20.42	0.64	3.11	20.51	0.84	4.08	20.10	0.62	3.11	21.01	0.09	0.44
Length of forearm	14.78	0.42	2.87	14.94	0.76	5.09	14.81	0.49	3.28	15.22	0.69	4.51
Arm - forearm	72.41	2.69	3.71	72.91	3.55	4.86	73.74	2.75	3.73	72.43	2.94	4.06
Length of lower limb	51.90	0.97	1.88	52.77	1.52	2.88	52.29	1.43	2.74	53.35	0.55	1.04
Length of shank	22.83	0.80	3.51	22.66	0.59	2.59	22.97	0.70	3.05	23.38	0.37	1.56
Width of shoulders	67.82	3.51	5.17	69.74	5.65	8.10	68.67	4.59	6.68	70.02	4.42	6.31
Width of pelvis	55.33	2.66	4.81	56.89	5.33	9.38	57.21	4.12	7.20	58.26	3.67	6.30
Pelvis – shoulders	81.70	4.16	5.09	81.60	4.65	5.69	83.42	5.30	6.35	83.20	0.60	0.72

Table 6. Statistical description of the morphology of individual types of venous anastomosis in left upper extremity

Trait	Types of venous anastomosis in right upper extremity											
	M (n = 14)			N (n = 17)			Y (n = 6)			I (n = 3)		
	x	s	v	x	s	v	x	s	v	x	s	v
Age	57.64	12.71	22.06	59.06	20.01	33.88	76.83	6.37	8.29	69.00	10.82	15.68
Body heigth	169.42	6.49	3.83	172.47	8.81	5.11	169.63	5.43	3.20	170.87	4.31	2.52
sst-v	30.41	1.35	4.44	32.12	1.74	5.43	29.62	1.53	5.17	29.40	1.76	5.98
sst-sy	51.56	3.31	6.42	51.56	3.14	6.10	51.83	2.36	4.55	52.43	2.76	5.27
sy-ti	44.41	2.51	5.65	45.01	2.67	5.93	44.73	2.41	5.38	45.00	1.80	4.01
ti-sph	38.50	2.06	5.36	39.32	2.48	6.31	38.75	1.37	3.54	39.93	1.51	3.79
b-sy	88.34	4.14	4.69	90.36	5.79	6.41	90.50	3.51	3.88	90.30	3.44	3.81
a-r	34.54	0.99	2.86	34.98	2.17	6.21	35.40	1.37	3.88	35.40	1.48	4.18
r-sty	25.16	1.15	4.56	25.31	1.81	7.16	26.03	1.51	5.82	26.30	1.41	5.36
a-a	35.64	3.01	8.44	35.43	2.26	6.38	35.97	2.23	6.19	35.57	3.23	9.09
thl-thl	30.86	2.20	7.13	29.85	1.57	5.26	30.10	2.05	6.82	31.40	3.27	10.43
ic-ic	29.25	2.35	8.05	28.99	2.15	7.42	29.25	1.11	3.79	29.63	1.53	5.17
cl-cm	7.15	0.52	7.23	7.32	0.52	7.14	7.63	0.43	5.60	7.60	0.17	2.28
Forearm width	5.93	0.36	6.15	5.97	0.44	7.37	6.07	0.08	1.34	6.37	0.23	3.63
Thigh width	10.61	0.98	9.26	10.28	0.94	9.15	10.50	0.38	3.61	10.13	0.70	6.93
mlt-mlf	7.22	0.43	5.98	7.15	0.50	7.00	7.23	0.23	3.23	7.30	0.26	3.62

The observations mentioned above do not relate exactly to the group analysed, for it must be pointed out that this group comprised subjects whose organisms had been devastated by various diseases and who were mostly advanced in age. Age is particularly decisive in the progressive degeneration of

Table 7. Statistical description of the morphology of individual types of venous anastomosis in left upper extremity framed in the quotient indices

Index	Types of venous anastomosis in right upper extremity											
	M (n = 14)			N (n = 17)			Y (n = 6)			I (n = 3)		
	x	s	v	x	s	v	x	s	v	x	s	v
Length of trunk	30.43	1.41	4.65	29.91	1.33	4.46	30.56	0.98	3.21	30.68	1.03	3.35
Shoulders – b.height	21.01	1.11	5.28	20.57	1.25	6.09	21.20	1.07	5.06	20.79	1.39	6.67
B.height – pelvis	17.26	1.12	6.51	16.84	1.28	7.61	17.24	0.25	1.47	17.34	0.46	2.68
Length of arm	20.40	0.57	2.78	20.29	0.94	4.62	20.87	0.26	1.24	20.71	0.41	1.96
Length of forearm	14.85	0.34	2.31	14.68	0.74	5.03	15.34	0.47	3.08	15.39	0.56	3.61
Arm – forearm	72.87	2.72	3.73	72.40	3.73	5.15	73.52	2.47	3.36	74.27	1.35	1.81
Length of lower limb	52.13	1.11	2.13	52.38	1.64	3.13	53.35	0.89	1.66	52.84	0.69	1.31
Length of shank	22.72	0.77	3.37	22.79	0.71	3.11	22.84	0.39	1.69	23.37	0.31	1.31
Width of shoulders	69.17	4.31	6.23	68.94	5.91	8.57	69.38	2.60	3.75	67.79	4.11	6.06
Width of pelvis	56.77	3.55	6.26	56.47	5.82	10.30	56.46	1.52	2.69	56.53	1.45	2.56
Pelvis – shoulders	82.20	4.71	5.73	81.90	4.69	5.73	81.49	3.90	4.79	83.52	3.46	4.14

Table 8. Comparison of the morphological traits in groups MM (n = 10) i NN (n=11) (vaules of t-test which are significant at the level $\alpha \leq 0{,}05$ are marked in bold type)

Trait	MM			NN			t-test	p
	x	s	v	x	s	v		
Age	60.00	10.08	16.80	56.00	21.75	38.85	0.53	0.6015
Body heigth	168.51	6.30	3.74	174.24	8.08	4.64	-1.80	0.0882
sst-v	30.46	1.40	4.61	32.41	1.81	5.58	-2.74	0.0131
sst-sy	51.64	2.54	4.92	51.82	3.81	7.34	-0.12	0.9020
sy-ti	43.63	2.27	5.20	45.78	2.33	5.09	-2.14	0.0457
ti-sph	38.37	2.35	6.13	39.31	2.03	5.17	-0.98	0.3388
b-sy	87.39	4.32	4.95	91.32	4.48	4.90	-2.04	0.0554
a-r	34.60	1.06	3.06	35.57	1.64	4.60	-1.60	0.1264
r-sty	24.99	1.17	4.70	25.72	1.74	6.76	-1.11	0.2799
a-a	35.11	2.29	6.52	35.66	2.00	5.60	-0.59	0.5607
thl-thl	30.51	2.18	7.16	29.68	1.10	3.69	1.11	0.2789
ic-ic	28.50	1.81	6.34	28.79	1.54	5.34	-0.40	0.6947
cl-cm	6.96	0.35	4.99	7.32	0.36	4.92	-2.32	0.0319
Forearm width	5.94	0.42	7.15	5.96	0.41	6.88	-0.13	0.8982
Thigh width	10.51	1.10	10.48	10.18	0.52	5.12	0.89	0.3862
mlt-mlf	7.11	0.41	5.80	7.21	0.42	5.83	-0.54	0.5925

an organism by causing flabbiness of the soft tissue and a fall in the body weight, which is connected with loss of muscle mass.

In the typologies of body build used in anthropology the body mass is also taken into consideration, besides length and width parameters. In the case of the group under study measurement of the body mass was impossible. This may justify the lack of an explicit relationship between the type of venous anastomosis and the type of body build, as such

Table 9. Comparison of the quotient indices of morphological traits in groups MM (n = 10) i NN (n=11)

Index	MM			NN			t-test	p
	x	s	v	x	s	v		
Length of trunk	30.65	1.01	3.30	29.73	1.40	4.72	1.70	0.1049
Shoulder - height	20.82	0.82	3.96	20.50	1.26	6.15	0.70	0.4921
B.height – pelvis	16.92	0.96	5.66	16.56	1.26	7.58	0.72	0.4799
Length of arm	20.54	0.58	2.80	20.44	1.03	5.01	0.28	0.7798
Length of forearm	14.83	0.40	2.68	14.77	0.87	5.90	0.21	0.8340
Arm - forearm	72.24	2.93	4.06	72.33	4.30	5.94	-0.05	0.9580
Length of lower limb	51.84	1.06	2.05	52.43	1.73	3.29	-0.92	0.3666
Length of shank	22.76	0.86	3.80	22.56	0.64	2.85	0.60	0.5573
Width of shoulders	68.03	3.74	5.50	69.20	6.86	9.91	-0.48	0.6387
Width of pelvis	55.22	2.92	5.28	55.96	6.41	11.46	-0.34	0.7398
Pelvis - shoulders	81.27	4.22	5.20	80.84	4.24	5.25	0.23	0.8173

a relationship cannot be derived only from analysis of the build of the skeleton of an individual. When the morphology of the human blood system is analysed it is necessary to include the measurements of the limb circumferences, which indirectly takes into consideration the muscle mass and the whole body mass. The examination of any relationship between type of body build and type of venous anastomosis should treat living individuals, while the data from post-mortem studies may be taken as extremely important material which shows the variety and morphology of the venous system.

Nevertheless, our results confirm the existence of a considerable differentiation of superficial venous connections in the upper extremity. Taking into consideration the previous suggestions that type N anastomosis (which characterises leptosomatic individuals) may be treated as if different in form from type Y, it can be stated that there are only two types of connection between cephalic and basilic veins, one with symmetrical tributaries to both (M, Fig. 1) and the second with a very complex tributary system to the basilic vein (Y, N, Fig. 2 and 3). Such a conclusion is consistent with the results of other authors, such as Bożilov and Krechowiecki [2, 9, 12] (Fig. 2–4).

Apart from the purely morphological data obtained in the study presented, it should be noted that there is the possibility of using the results obtained in medical practice. Currently functionally advanced vein disease is very often pointed to as being the cause of lymphodoema. In recent years an increase in venous system disease has been reported, especially in the lower limbs. Body position during work and nature of occupation are among the most significant factors leading to the appearance of venous disease. Technical development and economic growth in developed countries has led to

Figure 2. M-type venous anastomosis.

Figure 3. N-type venous anastomosis.

Figure 4. Y-type venous anastomosis.

a decrease in physical activity in society. Unfortunately it is one of the main reasons for the appearance of failure of the venous system in the lower limbs. One can imagine the social importance of the problem of chronic failure of deep veins in the lower limbs, when it is taken into account that in the USA every year about 900,000 new cases are reported [6].

An essential problem which is closely connected with the venous anastomosis issue is that of the lymphatic system. It has been found in studies of lymphodoema in women after mastectomy that in patients with Y-shaped venous anastomosis the swelling either does not appear or is insignificant (Jasiński et al. 1999). This observation and earlier findings confirm the suggestions that the whole volume of the circulating lympha is not transferred to the blood system in the region of venous angles. Probably the small lymphatic vessels can drain the large blood vessels (e.g. in the extremities) thereby passing part of the lymph to the blood system. It has also been pointed out that negative venous pressure could influence indirectly the lymphatic vessels lying near the venous ones. Nevertheless, this problem remains a hypothesis and presents itself as the subject of ongoing investigations [4, 14, 15].

CONCLUSIONS

As a result of a dissection of the elbow fossa region, two fundamental types of venous anastomosis were distinguished:

— with symmetrical tributary veins to v. cephalica et v. basilica (M);

— with a very rich system of tributary veins to v. basilica (N, Y).

Individuals with N-type anastomosis are characterised by greater values of longitudinal parameters, which indicates the leptosomatic type of body build.

In the light of the development of modern techniques in vessel surgery of lower limb diseases, the conduct of further research on anatomical and morphological pictures of the upper limb venous system seems to be highly justified.

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