

# Variability of the v. cava caudalis and Its Tributaries in Some Laboratory Animals. II. The Laboratory Rat (*Rattus norvegicus* v. *alba*)

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**ABSTRACT** Duplication of the v. renalis was found in 11 of the regions examined (18.3%), when it was more frequent on the right side. A v. capsularis was found in 35 regions (58.3%), usually as a single vein. There were 1-3 vv. suprarenales (but mostly two; on the right they usually joined the v. cava caudalis and on the left the v. renalis sinistra). A v. spermatica was present on the right side in every case, but on the left side in 11 cases only; in one case it was duplicated. In the rat, the v. spermatica was rather thin; if absent, it was replaced by the v. deferentialis. In nine cases (60.0%) the v. uterina cranialis dextra opened into the v. cava caudalis, while in 12 cases (80.0%) the left vein opened into the v. renalis sinistra. A v. uterina media, draining blood from the caudal third of the cornu uteri, was found in only five cases (16.7%). The v. uterina caudalis drained blood from the corpus and cervix uteri. The v. ovarica was a constant finding; it was mostly joined by the v. lumbalis - and on the left side by the v. phrenica sinistra.

In males, the vv. lumbales occurred mostly as a pair of veins lying just below the vv. renales. In females, they were present on both sides. As a rule, the v. iliolumbalis occurred as a single vein on both sides. The v. cava caudalis originated at the level of the transition between the lumbar and the sacral spine, usually at the confluence of the two vv. iliaca communes, which in 14 cases (46.7%) were joined by the v. sacralis mediana. Duplication of the v. cava caudalis was found in only one case (a female). Comparison of the morphology of the v. cava caudalis and its tributaries in the rat and the guinea pig showed more slight differences between the two species.

**Key words:** Laboratory rat - v. cava caudalis - tributaries - variability

## INTRODUCTION

In our preceding paper (Malinovský et al. 1951) we studied the organization of the v. cava caudalis and its tributaries in guinea pigs, as this problem has previously received little attention in the literature. The only detailed study is the one by Habermehl (1951-52), who investigated the v. cava caudalis and its variability in 15 cats of both sexes. The remaining literature on the v. cava caudalis deals mostly with its development in different species, including man, and with the explanation of variability of the organization of this vein (for a survey of the literature see Malinovský et al., 1991). Del Campo and Ginther (1972) studied the veins of the uterus in the guinea pig, rat, golden hamster and rabbit, but the number of animals examined was relatively small. Butler (1927) and Reagen (1927) studied the development of the v. cava caudalis in the rat and Greene (1959) described in his atlas the morphology of the rat's venous system.

Our previous results and the literature to date show that, as regards their number and where they

open, the tributaries of the v. cava caudalis are highly variable. Species differences also exist (e.g. the opening of the v. spermatica dextra). The latest morphological manuals are probably based on the examination of only a small number of individuals, so that their data are often inaccurate. There are also problems regarding terminology (e.g. the definition of the v. iliolumbalis).

For the above reasons, we decided to pay attention to the laboratory rat (order Rodentia, family Muridae).

## MATERIAL AND METHODS

The morphology of the v. cava caudalis and its tributaries was studied in 30 adult laboratory rats (*Rattus norvegicus* var. alba) - 15 males and 15 females. The abdominal cavity was opened under general anaesthesia and the v. cava caudalis and its tributaries were injected via the liver with blue-dyed latex. After the material had been fixed in 5% formalin and the latex had hardened, the venous bed was dissected out in detail. Owing to

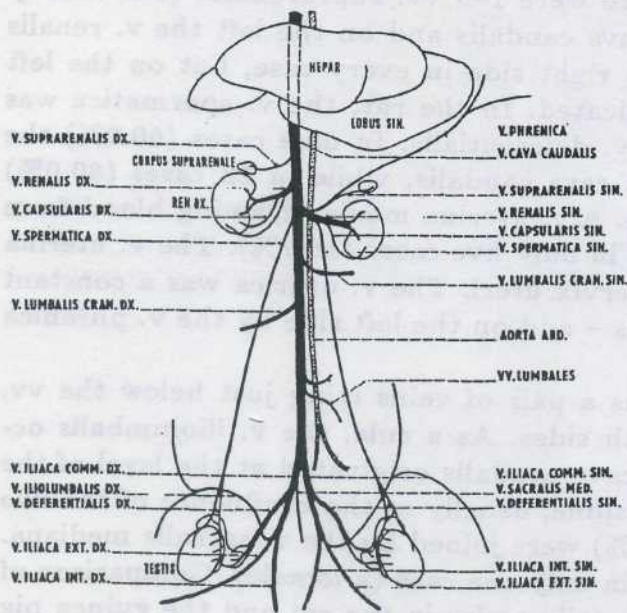


Fig. 1. The v. cava caudalis and its tributaries in the laboratory rat. A male.

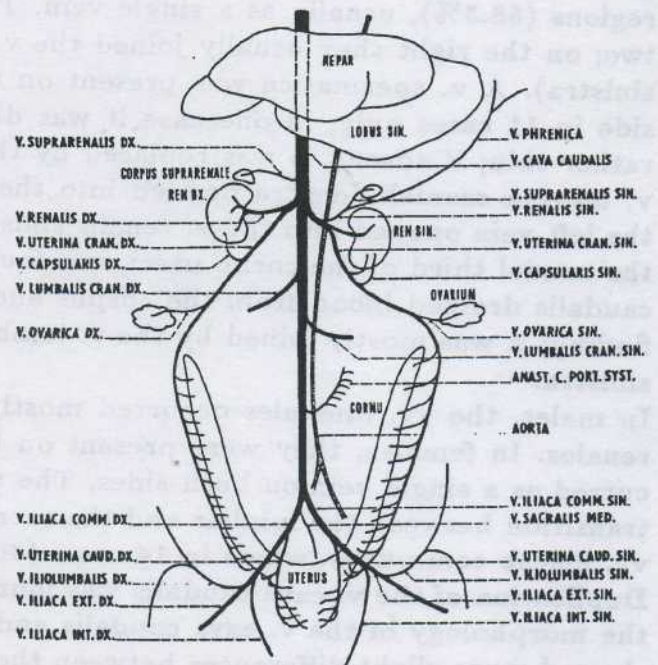


Fig. 2. The v. cava caudalis and its tributaries in the laboratory rat. A female.

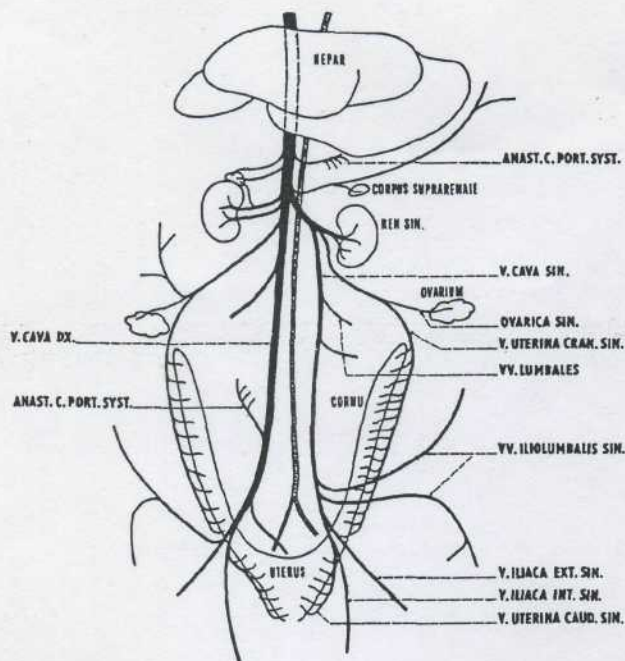


Fig. 3. Duplication of the v. cava caudalis in the laboratory rat. A female.

fragility of the veins, the findings were drawn immediately and because of the mode of injection the v. cava caudalis was studied in the subhepatal region. The incidence of the veins was evaluated with reference to the number of cases (15 males and 15 females) and with reference to the region (i.e. the right and the left side - in all, 60 regions in both sexes).

## RESULTS

The largest side tributaries of the v. cava caudalis are the vv. renales. Since development on either side is different, the two sides were studied separately, with reference to possible sex-related differences. When evaluating the connection relationships of the two vv. renales, the position of the kidneys should be taken into account, as the right kidney is situated further cranially than the left kidney.

The levels at which the vv. renales open are shown in Tab 1. It can be seen that in most cases and in both sexes the v. renalis dextra opens cranially to the opening of the v. renalis sinistra, so

Table 1. Levels at which the vv. renales open into the v. cava caudalis

Relation to the opposite vein	dx male	dx female	sin male	sin female
cranial	14	13	1	2
at the same level	-	-	-	-
caudal	1	2	14	13

that it reflects the more caudal position of the left kidney.

The number of vv. renales, according to sex and side, is given in Tab. 2. Duplication of this vein was found in 11 renal regions (18.3%). In 41 regions (81.7%) there was only one v. renalis. No significant inter-sex differences were found, although the male: female duplication ratio was 4:7. Duplication on the right side was more frequent than on the left (10:1).

Table 2. Number of vv. renales related to sex and side

N	dx male	dx female	sin male	sin female
1	12	8	14	15
2	3	7	1	-

As a rule, the vv. renales receive one or more tributaries from neighbouring veins. A survey of their number, according to sex and side, is given in Tab. 3. Neither sex- nor side-related differences were observed. The most frequent number of trib-

Table 3. Number of tributaries of the vv. renales related to sex and side

N	dx male	dx female	sin male	sin female
0	3	3	1	-
1	5	5	3	3
2	4	4	7	6
3	3	2	4	5
4	-	-	-	1
5	-	1	-	-

Table 4. Tributaries of the vv. renales related to sex and side

Vein	dx male	dx female	sin male	sin female
v. suprarenalis	5	7	12	14
vv. suprarenales	-	1	-	-
v. lumbalis	2	1	3	5
v. spermatica	6	-	8	-
v. uterina cranialis	-	5	-	12
vv. capsulares	4	5	3	2
v. phrenica	1	-	1	2

utaries was two (about one third of the renal regions).

The last question studied in the vv. renales region were the tributaries of the vv. renales and their relationship to sex and side. A survey is given in Tab. 4. On the right side the tributaries were very variable, while on the left the most frequent tributaries were the vv. suprarenales (in both sexes) and (in females) the v. uterina cranialis sinistra.

A v. capsularis, draining blood from the surface of the kidney, was not a constant finding (58.3% of the regions). A survey of its incidence and opening, according to sex and side, is given in Tab. 5. In females it opened the most often, on both sides, into the v. uterina cranialis, while in males it opened into the v. renalis and the cranial v. lumbalis. The incidence and number of vv. capsulares, according to sex and side, are given in Tab. 6, which shows that they were missing in 23

Table 5. Incidence and opening of the v. capsularis related to sex and side

Vein	dx male	dx female	sin male	sin female
v. spermatica	1	-	2	-
v. uterina cranialis	-	8	-	9
v. lumbalis	5	-	5	1
v. renalis	5	4	5	1
v. ovarica	-	1	-	2
v. cava caudalis	1	-	-	-
v. suprarenalis	-	-	5	2

Table 6. Number of vv. capsulares related to sex and side

N	dx male	dx female	sin male	sin female
0	9	7	8	1
1	4	6	4	13
2	-	1	1	-
3	2	1	2	1

regions (41.1%). One vein was found relatively often. The incidence in females was higher than in males.

Vv. suprarenales were normally found on both sides and in both sexes. Their numbers, according to sex and side, are given in Tab. 7. Although there were 1-3 such veins, one was the commonest number (75% of the regions). Multiplication of these veins was more frequent on the right side (13:2 in relation to the left side). Some vv. suprarenales opened into the v. renalis, other into the v. cava caudalis. For the manner of the opening, according to sex and side, see Tab. 8. On the right side they opened more often, in both sexes, into the v. cava caudalis (ratio 19:4), while on the left side they opened more often into the v. renalis (ratio

Table 7. Number of vv. suprarenales related to sex and side

N	dx male	dx female	sin male	sin female
1	10	7	13	15
2	5	7	2	-
3	-	1	-	-

Table 8. Opening of the vv. suprarenales related to sex and side

Tributary of the	dx male	dx female	sin male	sin female
v. renalis	6	8	11	15
v. cava caudalis	10	9	4	-

26:4). The vv. suprarenales dextrae did not receive any tributaries. On the left side, in both sexes, they were generally joined by the v. phrenica sinistra (in males in 13 cases., in females in 12 cases). On the left side, in several cases, they were further joined by the v. capsularis (see Tab. 5).

The v. spermatica was a relatively thin vein draining blood from the testis. In the rat, the testis is constantly situated in a scrotum. The vein originates as the plexus pampiniformis. On the right side it was found in all 15 cases; on the left side the v. spermatica sinistra was absent in three cases and in one case it was duplicated (in the other 11 cases it was single). On the right side the v. spermatica joined the v. cava caudalis in eight cases and the v. renalis dextra in six cases. On the left side it joined the v. renalis in 10 cases and opened into the v. cava caudalis in only four cases. In one case both vv. spermaticae opened into the v. renalis sinistra. It can be regarded as the norm that the v. spermatica opens into both the v. cava caudalis and the v. renalis dextra on the right side and into the v. renalis sinistra on the left side.

A survey of the tributaries of the vv. spermaticae is given in Tab. 9. Relatively often the vein receives no tributaries. On the right side it anastomoses relatively frequently with the v. deferentialis (12 regions, i.e. 40.0%). The anastomosis is relatively thick and could thus explain the absence of a v. spermatica in three cases.

Table 9. Tributaries of the vv. spermaticae related to side

Tributaries	dx male	sin male
without tributaries	7	5
v. capsularis	2	4
anastomosis with v. deferentialis	8	4
anastomosis with v. cava caudalis	1	-

The v. uterina cranialis runs over the lateral surface of the uterus, where it is joined by short veins from the uterus. It was found in every case and on both sides. The right vein opened into the v. cava caudalis in nine cases (60.0%) and into the v. renalis dextra in six cases (40.0%). The left

Table 10. Tributaries of the vv. uterinae craniales related to side

Tributaries	dx female	sin female
v. ovarica	15	15
v. lumbalis	-	3
v. capsularis	8	11
	(altogether 12 veins)	(altogether 16 veins)

vein opened into the v. renalis sinistra in 12 cases (80.0%) and into the cranial v. lumbalis in three cases (20.0%). The norm can be considered to be opening of the v. uterina cranialis dextra into the v. cava caudalis and of the v. uterina cranialis sinistra into the v. renalis sinistra. The tributaries of the v. uterina cranialis, according to side, are shown in Tab. 10. The v. ovarica was found to be a constant tributary and the v. capsularis a frequent tributary.

A v. uterina media, draining blood from the caudal third of the cornu uteri, was found in five cases (33.3%); it always occurred on one side only. In four cases it joined the v. uterina caudalis and in one the v. iliaca communis. Cranially, it had no connections with the v. uterina cranialis.

The v. uterina caudalis originated from the corpus and cervix uteri. In the corpus uteri it sometimes anastomosed with the v. uterina cranialis and in two cases, on both sides, with the v. uterina media also. This vein was found in every case and on both sides. A survey of its opening is given in Tab. 11. Most often it opened, on both sides,

Table 11. Opening of the vv. uterinae caudales related to side

Vein	dx female	sin female
v. iliaca communis	9	9
v. iliaca interna	4	3
v. iliaca externa	1	2
v. iliolumbalis	-	2
v. cava caudalis	1	-

Table 12. Tributaries of the vv. ovaricae related to side

Tributary	dx female	sin female
v. capsularis	1	1
v. lumbalis	8	6
v. phrenica	-	8
without tributaries	7	1

into the v. iliaca communis (60.0% of all the regions examined).

A v. ovarica was present in every case and on both sides. Its tributaries are shown in Tab. 12. Most often it was joined by vv. and, on the left side, by the v. phrenica.

The vv. lumbales were not arranged segmentally. As a rule, the thick dual cranial vv. lumbales were situated just caudally to the vv. renales. In most cases the right cranial vein joined the v. cava caudalis caudally to the left vein. No significant sex-related differences were found in this relationship. The veins were formed below the ventral muscle system of the spinal cord; they drained blood from the dorsal abdominal wall, from the diaphragm to the region of the v. iliolumbalis. Other, thinner tributaries came from the ventral abdominal wall. If further, more caudally situated vv. lumbales occurred, they were very thin and short. The number of vv. lumbales varied from one to seven; a survey of their incidence (including sex and side) is given in Tab. 13, which shows that in males there was usually one v. lumbalis on either side (76.7% of the regions), while in females there were more often two vv. lumbales on both

Table 13. Incidence of the vv. lumbales related to sex and side

N	dx male	dx female	sin male	sin female
1	12	6	11	5
2	2	7	1	7
3	1	2	3	1
4	-	-	-	-
7	-	-	-	1

Table 14. Opening of the vv. lumbales related to sex and side

Tributary of the	dx male	dx female	sin male	sin female
v. cava caudalis	14	13	12	9
v. renalis	2	1	3	4
v. spermatica interna	-	-	1	-
v. ovarica	-	8	-	5
v. uterina cranialis	-	-	-	5

sides. Connection of the vv. lumbales, according to sex and side, is shown in Tab. 14. In both sexes and on both sides they mostly joined the v. cava caudalis; in females they also joined the v. ovarica (on both sides) and the v. uterina cranialis (on the left side). As a rule, the vv. lumbales had no tributaries and the only occasional tributary was the v. capsularis.

We describe the vein originating as a result of the connection of tributaries from the lumbar and iliac regions as the v. iliolumbalis. In every case and on both sides there were one or two such veins. Duplication occurred in five cases in females, but in only one case in males. For a sex and side survey of opening of the v. iliolumbalis see Tab. 15. It can be seen that there were no significant differences between the sexes and the sides. The v. iliolumbalis opened mostly into the v. iliaca communis and the v. iliaca externa. These seldom had any tributaries, but were occasionally joined by the v. deferentialis (4 cases).

As a rule, the v. cava caudalis originated at the level of the transition between the lumbar and sacral spine, by confluence of the v. iliaca commu-

Table 15. Opening of the vv. iliolumbales related to sex and side

Vein	dx male	dx female	sin male	sin female
v. iliaca communis	6	7	10	9
v. iliaca externa	5	9	5	6
v. iliaca interna	1	-	-	-
v. cava caudalis	3	1	1	-
v. cava caudalis sinistra	-	-	-	1

Table 16. Tributaries of the v. cava caudalis related to number, sex and side

Tributary	dx	dx	sin	sin
	male	female	male	female
v. renalis	15	15	15	15
v. capsularis	1	-	-	-
v. suprarenalis	10	9	4	-
v. spermatica	8	-	4	-
v. uterina cranialis	-	9	-	-
v. uterina caudalis	-	1	-	-
v. lumbalis	14	13	12	9
v. iliolumbalis	3	1	1	-
			male	female
v. sacralis mediana			7	4
portocaval anastomosis with v. colica sinistra			8	9
portocaval anastomosis with v. spermatica interna			2	-
portocaval anastomosis with v. deferentialis			1	-

nae. In 14 cases (46.7%), in both sexes, this confluence was also joined by the v. sacralis mediana. Duplication of the v. cava caudalis was not observed in males; in females it occurred in one case. A survey of all the tributaries of the v. cava caudalis, according to sex, size and number, is given in Tab. 16, which shows that the vv. renales were constant, and vv. lumbales almost constant, tributaries on both sides. On the right side the v. cava caudalis was often joined by the vv. suprarenales and, in females, by the v. uterina cranialis. Relatively often there were portocaval anastomoses with the v. colica sinistra (56.7% of the cases), but rarely with the v. spermatica (6.7%) and the v. deferentialis (3.3%).

No constant relationship between the v. cava caudalis and the aorta was observed. The different variants that were found are shown in Tab. 17. The aorta was situated to the left of the v. cava caudalis in 66.7% of the cases, but a ventral and dorsal localization were also found (both in 13.3%). The level of the origin of the v. cava caudalis in relation to the level of bifurcation of the aorta was likewise studied (Tab. 18). The v. cava caudalis originated caudally to the site of bifurcation or level with it.

Table 17. Mutual relation of the v. cava caudalis and aorta abdominalis

Position of the aorta	male	female	altogether
	left to the v. cava caudalis	11	9
behind the v. cava caudalis	4	1	5
between both vv. cavae	-	1	1
in front of the v. cava caud.	-	4	4

Table 18. Level of origin of the v. cava caudalis and branching of the aorta abdominalis related to sex

Aorta related to the v. cava caudalis	male	female
cranial	8	10
caudal	1	-
at the same level	6	4

The v. sacralis mediana was absent in six cases in males and in four cases in females. A survey of the incidence of this vein in relation to sex is given in Tab. 19, which shows that it frequently takes part in the origination of the v. cava caudalis. Relatively often it joins the v. iliaca communis dextra.

Table 19. Incidence and opening of the v. sacralis mediana related to sex

Tributary of	male	female
v. cava caudalis	7	4
v. iliaca communis dextra	2	5
v. iliaca communis sinistra	-	1
v. cava caudalis dextra	-	1

## DISCUSSION

The above findings can be compared only with our preceding description of variability of the v. cava caudalis and its tributaries in the guinea pig (Malinovský et al., 1991). In the rat, the v. renalis dextra opens in most cases, and in both sexes, cranially to the opening of the v. renalis sinistra. Relationships in the male guinea pig are

the same, but in females the *v. renalis dextra* opens both cranially and caudally to the *v. renalis sinistra* in an equal number of cases. In this respect, therefore, there are inter-sex differences in the guinea pig. In the cat (irrespective of sex), the *v. renalis dextra* emptied in half the cases caudally to the *v. renalis sinistra* (Habermehl, 1951-52). In the mole and the rabbit the *v. renalis sinistra* opens into the *v. cava caudalis* caudally to the *v. renalis dextra* (Zumstein, 1898) and the same relationships were described in the dog (Pohle, 1920).

A single *v. renalis* occurred in 45 out of 60 regions (81.7%) examined in the rat and in 43 regions (71.7%) in the guinea pig. In a comparison of the two species, multiplication of the *v. renalis* was more frequent on the right side (10:1 in the rat, 15:2 in the guinea pig). In both species the *vv. renales* mostly had two tributaries, irrespective of side and sex. In the rat they were more variable, however (in addition to the *vv. suprarenales*, *vv. lumbales* and *vv. spermaticae* or *vv. uterinae craniales* they also include the *vv. capsulares* and *vv. phrenicae*). The most frequent tributaries, in both species, were the *vv. suprarenales* and *vv. spermaticae* or *vv. uterinae craniales*.

*Vv. capsulares* occurred in the rat in 35 regions (58.3%), usually as single veins. They were found in females more often than in males. The frequency of their incidence in guinea pigs was about the same and no inter-sex differences were found. In male rats, the *vv. capsulares* opened mostly into the *v. renalis* and cranial *v. lumbalis*, but in females into the *v. uterina cranialis*. In guinea pigs of both sexes, the *v. capsularis* opened the most frequently, on both sides, into the *v. spermatica* or *v. uterina cranialis* and into the *vv. lumbales*. In the cat, Habermehl (1951-52) mentioned the *v. capsularis*, but without going into details.

*Vv. suprarenales* occurred regularly in both the rat and the guinea pig, on both sides and in both sexes. In the rat a single vein was the most usual (75.0% of the regions), while in the guinea pig there were usually two veins (56.7% of the regions). In the rat, the *v. suprarenalis dextra* opened more often, in both sexes, into the *v. cava caudalis*, while the left vein, in both sexes, opened into the *v. renalis sinistra*. Similar relationships

were found in the guinea pig; in this species, opening into the *v. lumbalis* was also found relatively often.

In the rat, the *v. spermatica* is a thin vein. It occurred on the right in every case, but on the left it was missing in three cases and was duplicated in one. In the guinea pig, however, it was fairly thick and its incidence was bilaterally constant. The reason for this difference could be that the rat has a relatively thick *v. deferentialis*, which in three cases replaced the *v. spermatica* (the guinea pig has a thin *v. deferentialis*). In the rat, the *v. spermatica dextra* joined the *v. cava caudalis* and *v. renalis dextra* in an equal number of cases; on the left it generally joined the *v. renalis sinistra*. In one rat, both *vv. spermaticae* emptied into the *v. renalis sinistra*. In the guinea pig, the right *v. spermatica* opened mainly into the *v. cava caudalis* and the left vein into the *v. renalis sinistra*. Similar relationships were described in the cat (Habermehl, 1951-52). In the rat, the *v. spermatica* was joined in 12 cases by the *v. capsularis* and in 12 cases it anastomosed with the *v. deferentialis*. In the guinea pig, relationships regarding the *v. capsularis* were the same and in six cases the *vv. spermaticae* were joined by *vv. lumbales*. On the right side, in both species, the number of tributaries was somewhat greater. According to Zumstein (1898), the veins from the gonads of the mole and the rabbit join the *v. cava caudalis*. In male cats, both *vv. spermaticae* open mostly into the corresponding *v. renalis* (Habermehl 1951-52). According to Pohle (1920), the dog *v. spermatica* usually joins the *v. cava caudalis*. In man, opening into the *v. cava caudalis* is described as the norm for the right side and opening into the *v. renalis sinistra* as the norm for the left side (Reis and Esenther, 1959).

In the rat, a *v. uterina cranialis* was found in every case. On the right it opened more frequently into the *v. cava caudalis* (60.0% of the cases) and on the left usually into the *v. renalis sinistra* (80.0% of the cases). The same relationships are to be found in guinea pigs. In the rat, the *vv. ovaricae* are constant, and the *vv. capsulares* frequent, tributaries of the *vv. uterinae craniales*; relationships in the guinea pig are similar. On the left, the *vv. uterinae craniales* are also joined by *vv. lumbales*. In the cat - according to Habermehl (1951-52) -



the v. uterina cranialis opens into the v. cava caudalis, as in the dog (Pohle 1920). Del Campo and Ginther (1972) described a v. uteroovarica in the rat. Since the v. uterina cranialis is a thick vein, however, we consider the v. ovarica to be only its tributary, as in the guinea pig (Malinovský et al., 1991).

A v. uterina media was found in five cases (16.7%) in the rat, but not in the guinea pig.

Vv. uterinae caudales were a constant finding in both rats and guinea pig, in both of which they mostly join the v. iliaca communis. Vv. ovaricae are likewise a constant finding in both these species. In the rat they are mostly joined by the vv. lumbales and vv. phrenicae, but in the guinea pig by the vv. lumbales and vv. capsulares.

The vv. lumbales are not arranged segmentally in either the rat or the guinea pig. In male rats, a single v. lumbalis was the most frequent, on both sides, while in females there were mostly two of these veins on both sides. The vv. lumbales are usually situated caudally to the vv. renales. In guinea pigs there were no sex- or side-related differences and 2-3 vv. lumbales were the most frequent. In the rat, the vv. lumbales most often joined the v. cava caudalis - in females the v. ovarica and on the left side the v. uterina cranialis also. The vv. lumbales mostly joined the v. cava caudalis in male guinea pigs and the v. renalis sinistra in females. In the rat, the vv. lumbales mostly had no tributaries and were joined by the v. capsularis in only 11 regions. In guinea pigs the vv. lumbales likewise had few tributaries - as a rule vv. capsulares (11 regions) and the vv. suprarenales (13 regions).

A v. iliolumbalis was found in the rat in every case (100.0%) and in the guinea pig in the majority of cases (83.3%). In both species they usually joined the v. iliaca communis and v. iliaca externa. No sex- or side-related differences were observed.

In both the rat and the guinea pig, the v. cava caudalis originated mostly by confluence of the two vv. iliaca communes, in about one third of the cases together with the v. sacralis mediana. Duplication of the v. cava caudalis was found in only one rat (a female). In guinea pigs, its duplication was found in three males, but only one female. Duplication is thus commoner in guinea

pigs. The tributaries of the v. cava caudalis in the two species are similar. Portocaval anastomoses (between the v. cava caudalis and the v. colica sinistra) were found in 17 rats (56.7%). In the guinea pig they occurred in only six cases, in which the v. colica media, as well as the v. colica sinistra, took part in their formation.

Comparison of the v. cava caudalis and the variability of its tributaries in the rat and the guinea pig revealed further differences. In the rat there were fewer vv. suprarenales and vv. lumbales and a v. uterina media was found in 16.7%. In some cases the v. spermatica was missing, but on the other hand, rats had a thick v. deferentialis. Duplication of the v. cava caudalis in our series was more frequent in guinea pigs (13.3% as against 3.3% in the rat).

The rat and the guinea pig both belong to the rodent order. The guinea pig comes from South America and stands close to the aplacental mammals, however. This specificity of the guinea pig's origin could be a source of morphological differences. A comparison with the literature shows that there are other differences between different orders - e.g. in the connections of the gonadal veins. The authors cited above examined only small series of the respective animals (Zumstein, 1898; Pohle 1920; Habermahl, 1951-52). A detailed comparison of their results with ours is therefore impossible. Our previous studies of variability of the v. portae in certain laboratory animals (see Navrátilová et al., 1991) indicate that various order and family differences can be anticipated. Further detailed studies, in a larger number of species, are needed to elucidate the question of order, family and species differences.

For an explanation of the development of the v. cava caudalis and variability of its tributaries, see our preceding paper (Malinovský et al., 1991).

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