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Origin of the V. Portae and Variability of Its Tributaries in Laboratory Animals. V. The Golden (Syrian) Hamster (*Mesocricetus auratus*)

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Our preceding systematic studies of the origin of the v. portae and its tributaries in the domestic cat (Malinovský and Navrátilová 1990a), the guinea pig (Navrátilová and Malinovský 1990a), the laboratory rat (Malinovský and Navrátilová 1990b) and the domestic rabbit (Navrátilová and Malinovský 1990b) brought us two important basic findings. Firstly, they demonstrated marked variability in the organization of the studied veins in all the laboratory species examined and secondly, they drew attention to significant differences between animals belonging to different orders. Since the existing relevant literature has virtually nothing to say on this question and the data in general comparative anatomy manuals are only fragmentary, we investigated a further member of the rodent order belonging to the hamster family. The only author to describe the venous system of the golden hamster so far is Michel (1961) and he did not pay attention to variability.

MATERIAL AND METHODS

The origin of the v. portae and the variability of its tributaries were studied in 30 golden hamsters (*Mesocricetus auratus*) of both sexes. The material was processed for examination in the same way as in previous studies (see Malinovský and Navrátilová 1990a). After adequate fixation, the venous system of the v. portae was dissected and the findings were drawn immediately. To allow comparison, the results were processed according to the same criteria as in our preceding studies (see above).

RESULTS

THE V. PORTAE (FIG. 1, 2)

The trunk of the v. portae, about 4 mm long, originates on the right side below the liver. In 16 cases (53.3 % – Fig. 2A) it was formed of three tributaries, in 11 cases (36.7 % – Fig. 2B) of four and in one case each (3.3 %) of two (Fig. 2C), five (Fig. 2D) and six (Fig. 2E). The v. mesenterica cranialis was a constant initial tributary (in all 30 cases – 100 %). The v. lienalis participated in formation of the v. portae in only 28 cases (93.3 %); in two cases (6.7 %) it was completely absent. One of these is illustrated in Fig. 2C, where the v. portae is formed by the v. mesenterica cranialis and v. gastroduodenalis. The other most frequent tributaries of the v. portae were the v. gastroduodenalis (18 cases – 59.9 %), v. pancreaticoduodenalis cranialis (10 cases – 33.3 %), v. gastroepiploica dextra (5 cases – 16.7 %), v. gastrica sinistra (5 cases – 16.7 %) and v. pylorica (3 cases – 10.0 %). In one case (3.3 % – see Fig. 2D), we found a venous anastomosis between the v. portae and the v. cava caudalis.

THE V. GASTRICA SINISTRA (FIG. 3)

The v. gastrica sinistra arises from the venous networks of the two surfaces of the stomach, adjacent to the curvatura minor ventriculi. Its trunk is formed between distinctly separated parts of the stomach (the pars pylorica and the fundus ventriculi). In 25 cases (83.3 % – Fig. 3A) it joins the v. lienalis as its last tributary. In four cases (13.4 % – Fig. 3B) it is independent tributary

of the v. portae (the last but one or the third). A doubled v. gastrica sinistra was found in one case (3.3 % – Fig. 3C); the cranial vein was a tributary of the v. portae and the caudal vein emptied into the v. linealis. In 19 cases (63.3 %), the v. gastrica sinistra had no further tributaries, but in nine cases (30.0 %) it was joined by the v. cardiaca, in one (3.3 %) by the v. pylorica and in one by the v. cardiaca and v. pylorica simultaneously.

A v. cardiaca (Fig. 4) was found in 25 cases (83.3 %). Its connections were very variable. In 10 cases (33.3 % – Fig. 4A) it was a tributary of the v. gastrica sinistra and in another 10 (33.3 % – Fig. 4B) a tributary of the v. gastroepiploica sinistra. In two cases (6.7 % – Fig. 4C) it was an independent tributary of the v. lienalis and in two cases (6.7 % – Fig. 4D) it joined the v. pancreaticoduodenalis cranialis; in one case only (3.3 % – Fig. 4E) it was an independent tributary of the v. portae. In five cases (16.7 %) there was no v. cardiaca and in its place there were 1–3 anastomoses between the cardia and the spleen.

A v. pylorica was observed in 29 cases (96.7 %). Most frequently (17 cases – 56.7 %) it was a tributary of the v. gastroepiploica dextra. In three cases (10.0 %) it opened separately into the v. portae, in another three it joined the v. lienalis and in three others the v. gastrica sinistra. In one case each it joined the v. gastroduodenalis and the v. pancreaticoduodenalis cranialis. In one case it was duplicated, both veins opening into v. gastroepiploica dextra. In one case the v. pylorica was absent, its place was taken by small venous tributaries of the v. gastroepiploica dextra.

THE V. PANCREATICODUODENALIS CRANIALIS (FIG. 5)

A v. pancreaticoduodenalis cranialis was present in 28 cases (93.3 %). This vein collects venous blood from the whole of the caput and corpus pancreatis and its connections are very variable. In 12 cases (40 % – Fig. 5A), together with the v. gastroepiploica dextra, it was a tributary of the v. gastroduodenalis. In eight cases (26.7 % – Fig. 5B) it was a tributary of the

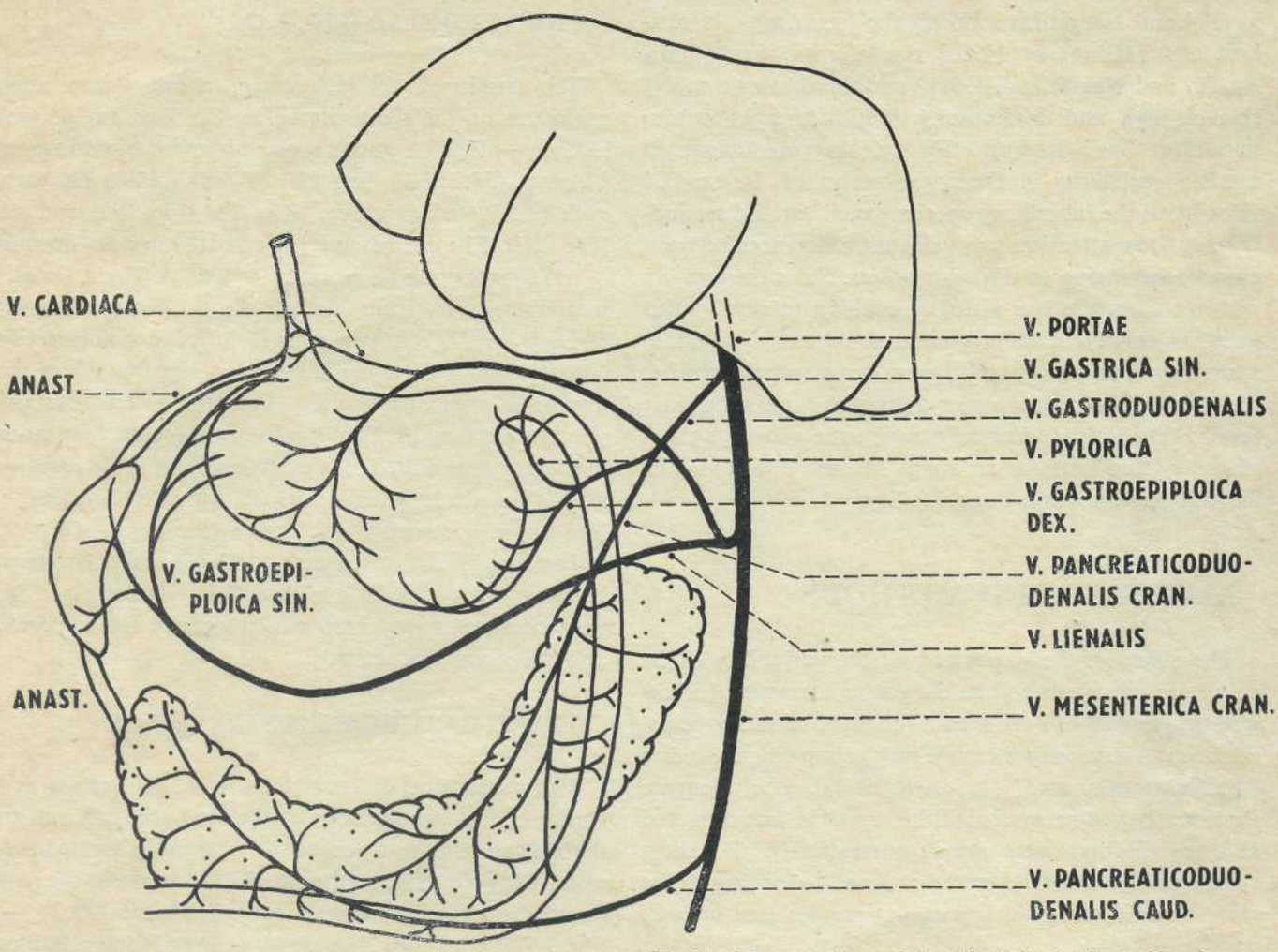

Fig. 1. The v. portae and its tributaries in the golden hamster, seen from behind.

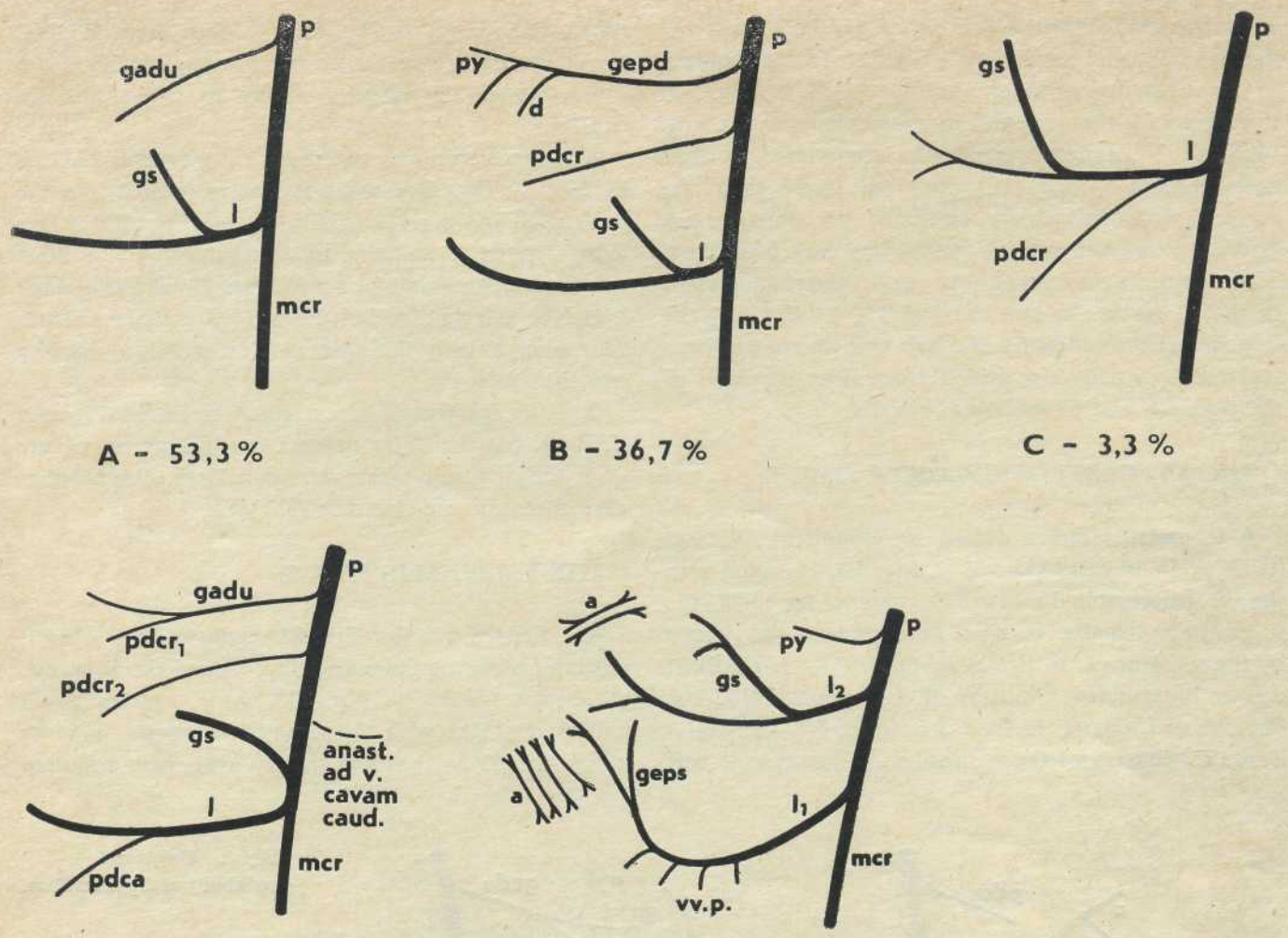

Fig. 2. Origin and variability of the v. portae.

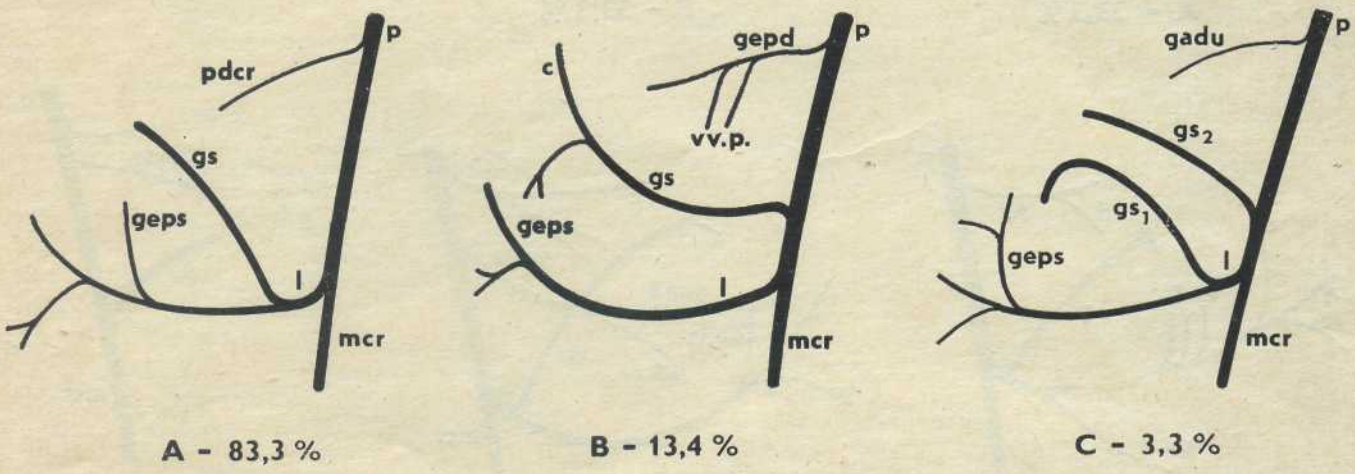

Fig. 3. Origin and variability of the v. gastrica sinistra

v. portae and collected blood only from the head of the pancreas. In two cases (6.7 % – Fig. 5C) it was a tributary of the v. lienalis and in another two (6.7 % – Fig. 5D) it united with the v. pancreaticoduodenalis caudalis to form a v. pancreaticoduodenalis communis. In four cases (13.3 % – Fig. 5E) there was more than one v. pancreaticoduodenalis cranialis; in three cases (10.0 %) it was duplicated and in one case triplicated. These veins again opened into the v. gastroduodenalis or the v. portae. In two cases (6.7 % – Fig. 5F) the v. pancreaticoduodenalis cranialis was absent and was replaced by small veins which arose from the head of the pancreas and joined the v. lienalis.

THE VV. GASTROEPIPLOICAE (FIG. 6)

A v. gastroepiploica dextra was found in 26 cases (86.7 %). In 16 cases (53.3 % – Fig. 6A) it united with the v. pancreaticoduodenalis cranialis to form the v. gastroduodenalis. In most cases it was also joined by the v. pylorica. In five cases (16.7 % – Fig. 6B), it was an independent tributary of the v. portae (the last but one or the last). In four cases (13.3 % – Fig. 6C) it was a tributary of the v. lienalis. In one case it was duplicated (3.3 % – Fig. 6D). In four cases (13.3 %) the v. gastroepiploica dextra was missing and blood was drained from the relevant region by the v. gastrica sinistra.

A v. gastroepiploica sinistra was observed in 22 cases (73.3 % – Fig. 6E), when it always opened into the v. lienalis. In 10 cases (13.3 % – see Fig. 6D) it was joined by the v. cardiaca. In eight cases (26.7 %) there was no v. gastroepiploica sinistra and blood was drained from the relevant region by the v. gastrica sinistra, anastomoses with the spleen or vv. gastricae opening into the v. lienalis.

Both vv. gastroepiploicae were present in 19 cases (63.3 %), but there was never a continuous venous arc along the curvatura major ventriculi. Both veins together were absent in one case only (3.3 %).

THE V. LIENALIS (FIG. 7)

A v. lienalis was found in 28 cases (93.3 %), when it was always one of the main tributaries of the v. portae. In 19 cases (63.3 % – Fig. 7A), the v. gastroepiploica sinistra, together with the v. gastrica sinistra, were its tributaries. The v. gastrica sinistra was main tributary

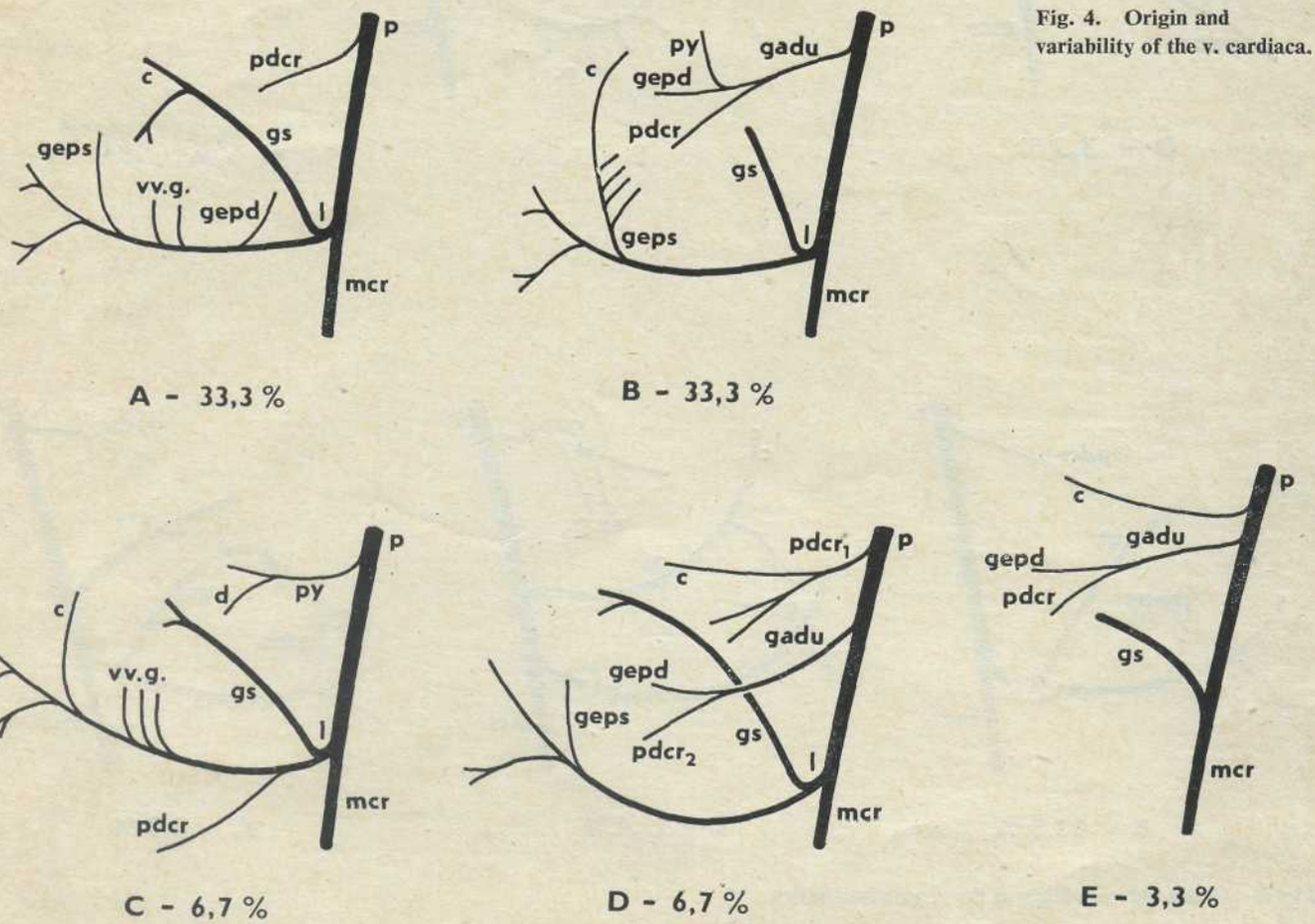

Fig. 4. Origin and variability of the v. cardiaca.

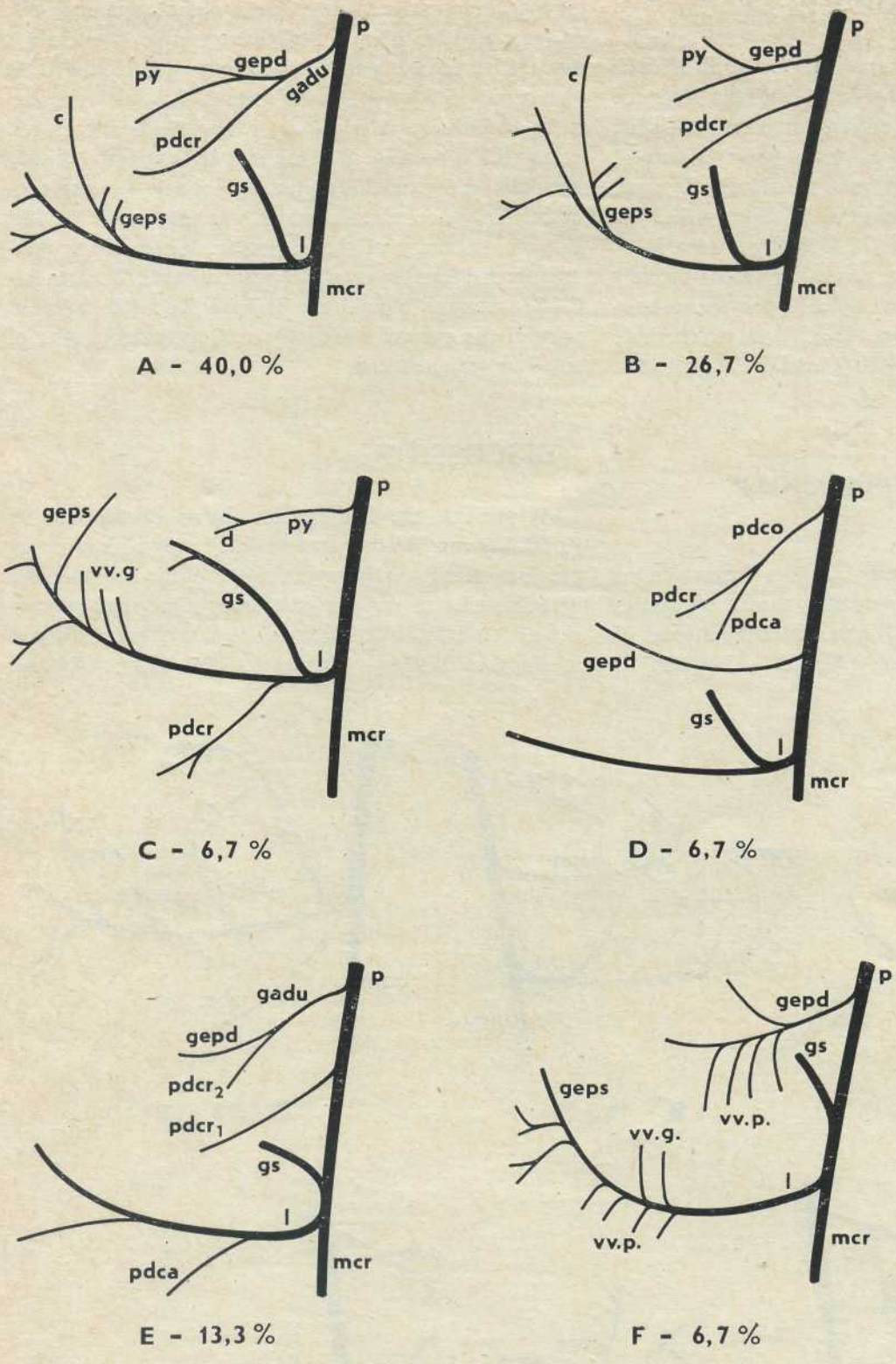

Fig. 5. Origin and variability of the v. pancreaticoduodenalis cranialis.

in five cases (16.7 % – Fig. 7B), the v. gastroepip'oica sinistra in two cases (6.7 % – Fig. 7C) and the v. pancreaticoduodenalis caudalis in one (3.3 % – Fig. 7D). Other veins emptying into the v. lienalis were the vv. pancreaticae and vv. gastricae, in three cases (10.0 %) the v. pancreaticoduodenalis caudalis and in two cases (6.7 %) the v. pancreaticoduodenalis cranialis and v. gastroepiploica dextra. In one case (3.3 % – Fig. 7E) the v. lienalis was duplicated; the main tributary of the cranial vein was the v. gastrica sinistra and of the caudal vein the v. gastroepiploica sinistra. In two cases (6.7% – Fig. 7F) the v. lienalis was missing. In these cases, venous blood was drained from the spleen by spleen-stomach inter-organ anastomoses and by anastomoses to the v. portae via the pancreas.

INTER-ORGAN ANASTOMOSES (SEE FIG. 7)

Inter-organ anastomoses were observed in all 30 cases (100 %). They occurred between the spleen and the stomach and between the spleen and the pancreas; stomach-pancreas anastomoses were never observed. Spleen-stomach anastomoses were found in 27 cases (90.0 %) when there were usually two (19 cases – 63.3 %). In the remaining eight cases (26.7 %) there were 1–5. In two of the above cases, the v. linealis was completely replaced by five anastomoses. Spleen-pancreas anastomoses were found in 28 cases (93.3 %), in which there were usually two or three (40.0 % and 36.7 %); in the remaining cases there were 1–4.

THE V. PANCREATICODUODENALIS CAUDALIS (FIG. 8)

The v. pancreaticoduodenalis caudalis drains venous blood from the tail of the pancreas by means of a series of small venous tributaries. It was found in a total of 28 cases (93.3 %). In 21 cases (70.0 % – Fig. 8A) it opened independently into the v. mesenterica cranialis; in one of these it was duplicated and in one case it formed three vv. pancreaticoduodenales caudales. In five cases (16.7 % – Fig. 8B), the v. pancreaticoduodenalis caudalis opened into the v. lienalis. Lastly, in two cases (6.7 % – Fig. 8C) the v. pancreaticoduodenalis cranialis and caudalis united to form a v. pancreaticoduodenalis communis, which was the last or the last but one tributary of the v. portae. Where the v. pancreaticoduodenalis caudalis was absent (2 cases – 6.7 %), venous blood was drained from the relevant part of the pancreas into the v. lienalis by means of small vv. pancreaticae.

DISCUSSION

At present, the findings on the v. portae and its variability can be compared in detail only with our own previous studies on the organization of the v. portae and its tributaries in various laboratory animals (Malinovský and Navrátilová 1990a – the cat, Navrátilová and Malinovský 1990a – the guinea pig, Malinovský and

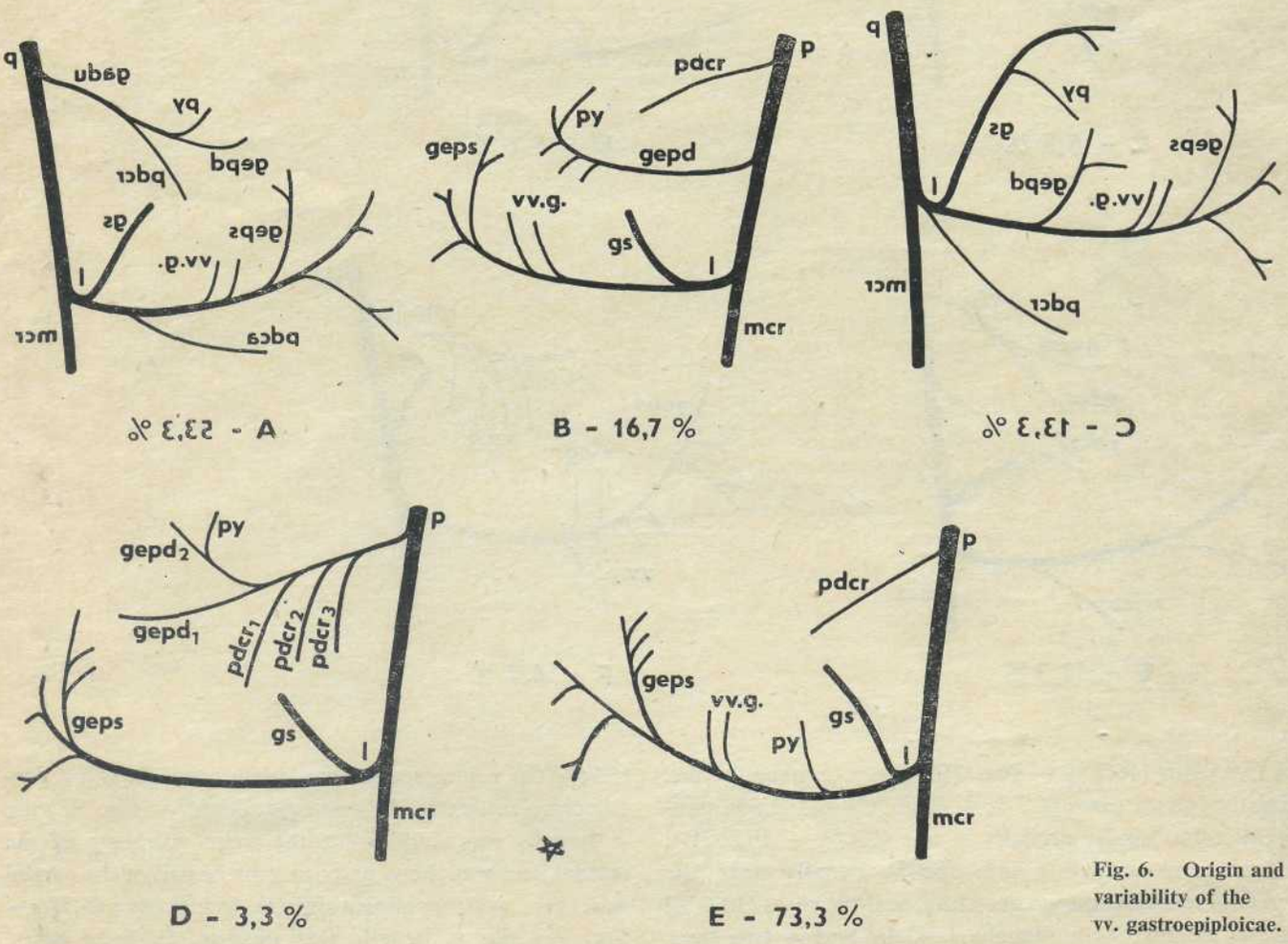

Fig. 6. Origin and variability of the vv. gastroepiploicae.

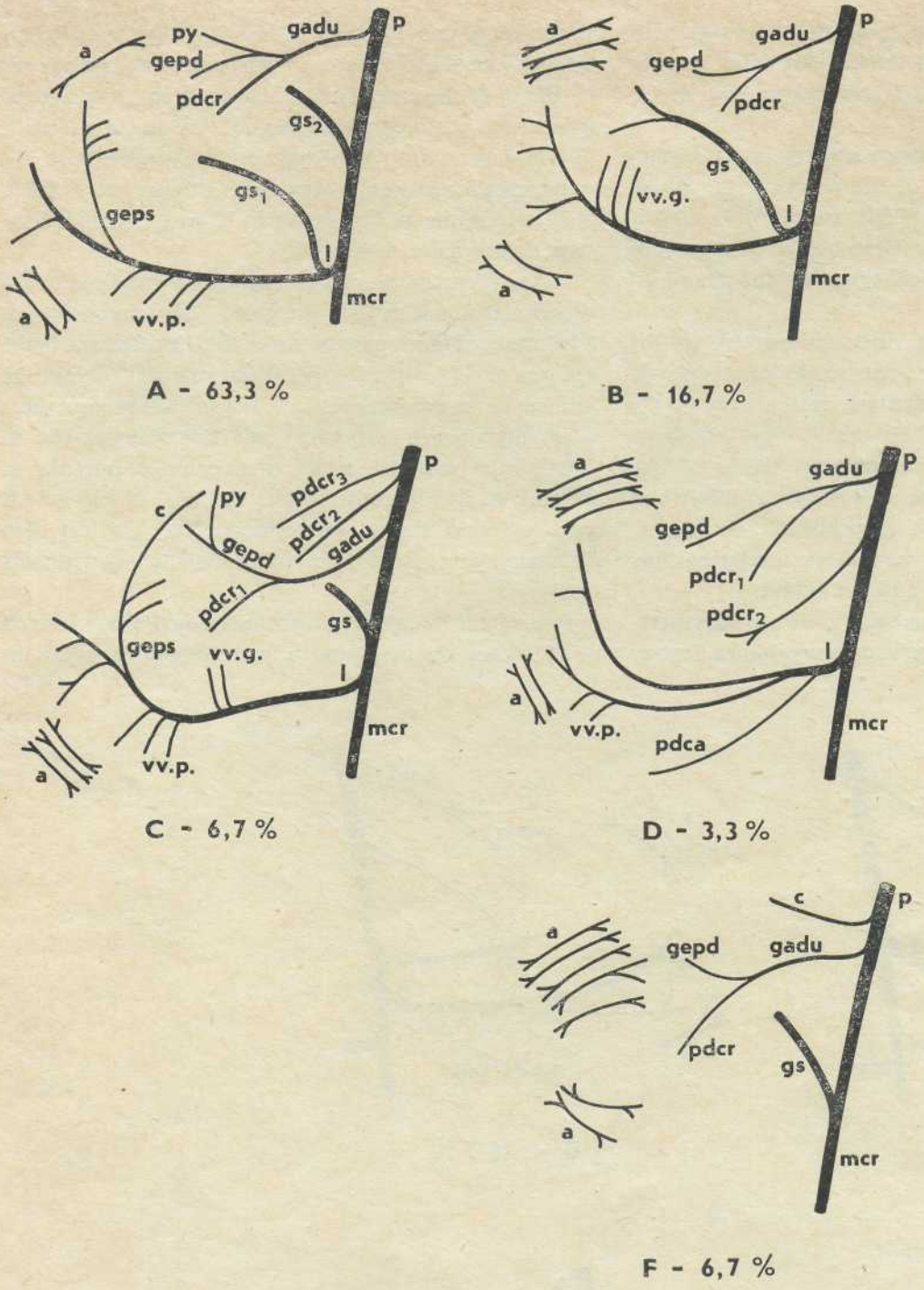

Fig. 7. Origin and variability of the v. lienalis.

Navrátilová 1990b – the rat, Navrátilová and Malinovský 1990b – the rabbit).

In the hamster the v. portae is formed of three tributaries in 53.3 % of the cases. The v. mesenterica cranialis is always a tributary and in most cases the v. lienalis is also. The next most frequent tributaries are the v. gastroduodenalis and v. pancreaticoduodenalis cranialis (in 36.7 % of the cases the v. portae is formed of four tributaries). In the rabbit the v. portae is formed mostly (53.3 %) from four tributaries and in the other laboratory animals examined from three veins – in 63.3 % of cats, 56.7 % of guinea pigs and 60.0 % of rats. In all the species examined, the v. mesenterica cranialis and v. lienalis are constant, or almost constant (hamster, rabbit), tributaries while the third and or fourth tributaries vary. The most frequent are the v. gastrica sinistra (the cat), the v. gastroepiploica dextra (the guinea pig), the v. pancreaticoduodenalis cranialis (the rat), the v. gastroduodenalis and v. pancreaticoduodenalis cranialis (the rabbit) and the v. gastroduodenalis and

v. pancreaticoduodenalis cranialis (the hamster). The v. portae tributary pattern in the hamster resembles the situation in other rodents and the rabbit and differs from the picture in the cat.

In the hamster, the v. gastrica sinistra is a tributary of the v. lienalis in 83.3 % of the cases, in the cat in 10.0 %, in the guinea pig in 80.0 % in the rat in 70.0 % and in the rabbit in 86.7 %. Here again, relationships in the hamster are closer to those in the examined rodents and the rabbit.

The v. cardiaca is most often connected to the v. gastrica sinistra or the v. gastroepiploica sinistra. It occurred in 83.3 % of hamsters, was absent in the cat and was present in 96.7 % guinea pigs (usually as a tributary of the v. gastrica sinistra), 100 % of rats (chiefly as a tributary of the v. gastrica sinistra) and 100 % of rabbits (mainly in association with the v. gastrica sinistra). Here again we can see a relationships between the various rodents and the rabbit.

A v. pylorica was found in 96.7 % of our hamsters, most often as a tributary of the v. gastroepiploica dextra. In the cat it was observed in 50.0 % of the cases (where usually joined the v. gastrica sinistra), in the guinea pig in 100 % of the cases (where it most frequently opened into the v. gastroepiploica dextra) and in rat in 100 % of the cases (most frequently in association with the v. pancreaticoduodenalis cranialis). It also had a 100 % incidence in the rabbit, in which it generally joined the v. gastroepiploica dextra.

In the hamster, the v. pancreaticoduodenalis cranialis was present in 93.3 % of the cases – most frequently as a tributary of the v. gastroduodenalis. Its incidence in the cat was 53.3 % when it most frequently united with the v. lienalis. It was found in 90.0 % of guinea pigs (here it usually opened into the v. gastrica sinistra) and in 100 % rats (where it most often emptied into the v. portae); its incidence in rabbits was 96.7 % and here it usually joined the v. gastroduodenalis. The cat thus differed again from the other laboratory animals examined.

In the hamster, a v. gastroepiploica dextra was formed in 86.7 % of the cases and v. gastroepiploica sinistra in

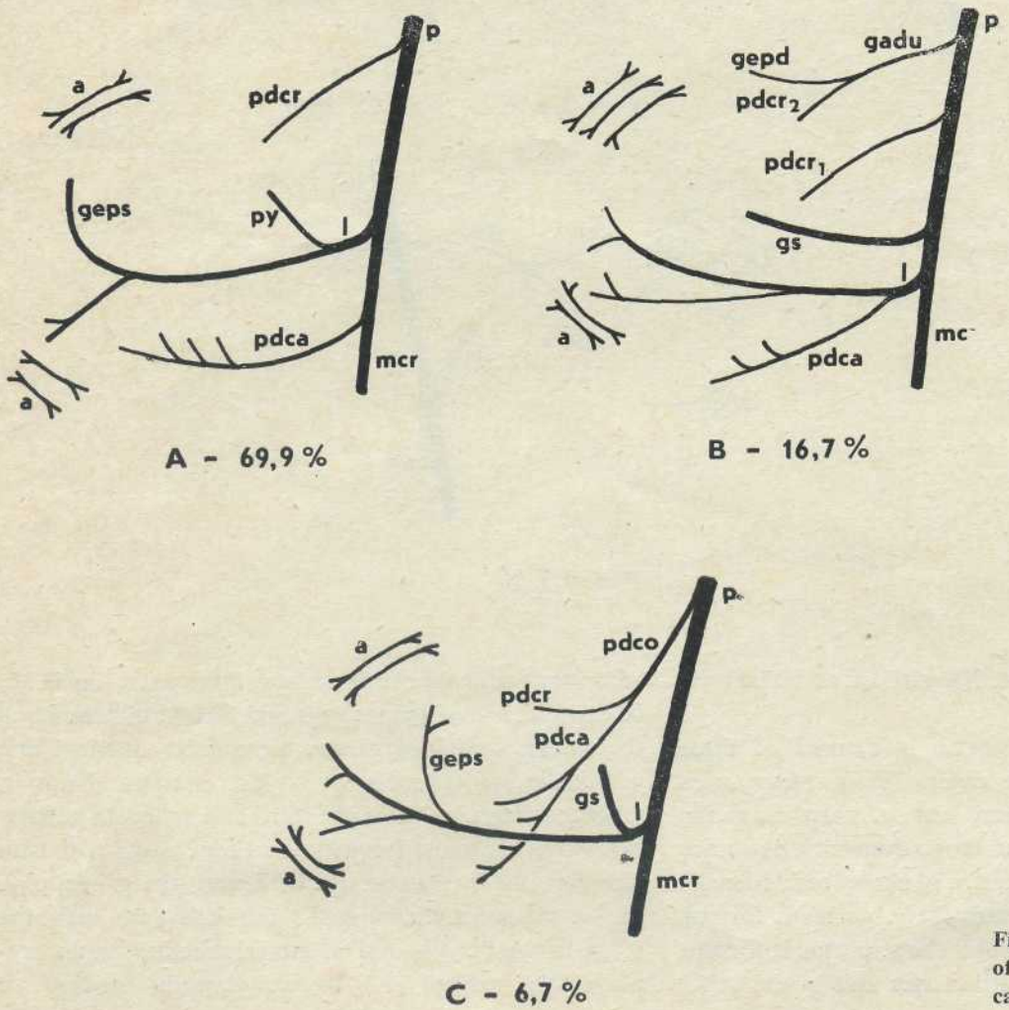

Fig. 8. Origin and variability of the v. pancreaticoduodenalis caudalis.

73.3 %; none of the animals had a complete venous arc along the curvatura major ventriculi. In the cat, a v. gastroepiploica dextra was observed in 33.3 % of the cases and a left vein in 23.3 %; a venous arc was seen in one case. In the guinea pig, a v. gastroepiploica dextra was found in 90.0 % of the cases and a left in 10.0 %; a complete venous arc was formed in 66.7 % of the cases. In the rat, the incidence of the v. gastroepiploica dextra was 36.7 % and of the v. gastroepiploica sinistra 6.7 %; none of the animals had a venous arc. In the rabbit, a v. gastroepiploica dextra was present in 89.9 % of the cases and a v. gastroepiploica sinistra in 86.7 %; a complete venous arc along the curvatura major ventriculi occurred in 33.3 %. The hamster and the rabbit thus display the greatest similarity as regards the frequency of incidence of the vv. gastroepiploicae.

Inter-organ anastomoses were found in all our hamsters (100 %), where they were formed between the spleen and the stomach (90 %) and between the spleen and the pancreas (93.3 %). In the cat, stomach-spleen anastomoses were found in 96.7 % of the cases and pancreas-spleen anastomoses in 20.0 %. In the guinea pig, the incidence of anastomoses between the stomach and spleen was 53.3 % and between the stomach, spleen and pancreas 33.3 % (total 86.7 %). In the rat, the incidence of the same anastomoses was 13.3 % and 73.3 % respectively (total 86.7 % of the cases). In the rabbit there was a 100 % incidence of anastomoses – in 89.9 % of the cases between the stomach, spleen and pancreas. The incidence of interorgan anastomoses is thus roughly the same in all the above species.

A v. pancreaticoduodenalis caudalis is formed in the hamster in 93.3 % of the cases; in 69.9 % it opens into the v. mesenterica cranialis. Its incidence in the cat was 60.0 % and it opened into the v. mesenterica cranialis in 40.0 %. The corresponding figures in the guinea pig were 96.7 % and 63.3 % and in the rat 100 % and 66.7 % respectively. This vein occurred in 100 % of rabbits and opened into the v. mesenterica cranialis in 70.0 %. It thus opened predominantly into the v. mesenterica cranialis in all the rodents and the rabbit. Its incidence in the cat was significantly lower.

A comparison of the given parameters leads to the following conclusions: The tributaries of the v. portae in the cat differ from those in the other species examined. The attachment of the v. gastrica sinistra is very similar in the rabbit, hamster and guinea pig, is somewhat different in the rat and is very different in the cat. The relationships of the v. cardiaca are close in the rabbit, rat and guinea pig, somewhat different in the hamster and very different in the cat. In the case of the v. pylorica, the findings in the cat differ markedly from the others. The incidence of the v. pancreaticoduodenalis cranialis is significantly lower in the cat. Relationships regarding the vv. gastroepiploicae are very similar in the hamster, guinea pig and rabbit and are different in the rat and the cat (where they are similar). Relationships as to the inter-organ anastomoses are not basically different. As regards the v. pancreaticoduodenalis caudalis, there are again significant differences between rodents and the rabbit on the one hand and the cat on the other.

Our findings in the hamster can be compared only with the description of the portal bed submitted by Michel (1961). The basic scheme of the tributaries of the v. portae is similar. A detailed comparison is not possible, however, as Michel did not investigate the variability of the tributaries of the v. portae.

Connection of the v. portae and the cava caudalis evidently originated as a result of connection of the anastomosing duodenal venous network (giving rise to the v. portae) with the hepatic segment of the v. cava caudalis.

SUMMARY

The authors studied the origin and variability of the v. portae in 30 adult golden hamsters (Mesocricetus auratus) of both sexes after injecting blue-dyed latex into their portal bed.

In 16 cases (53.3 %) the v. portae was formed from three tributaries and in 11 cases (36.7 %) from four. The v. mesenterica cranialis was the only constant tributary, the v. lienalis was a tributary in 28 cases (93.3 %) and the other most frequent tributaries were the v. gastroduodenalis and the v. pancreaticoduodenalis cranialis. In one case there was an anastomosis between the v. portae and the v. cava caudalis.

In 25 cases (83.3 %) the v. gastrica sinistra joined the v. lienalis, in four (13.3 %) it was an independent tributary of the v. portae and in one case (3.3 %) it was duplicated.

A v. cardiaca was found in 25 cases (83.3 %), when it was most frequently a tributary of the v. gastroepiploica sinistra and v. gastrica sinistra. In one case only it was an independent tributary of the v. portae.

A v. pylorica was observed in 29 cases (96.7 %), usually (in 17 cases – 56.7 %) as a tributary of the v. gastroepiploica dextra; in three cases it was an independent tributary of the v. portae (10.0 %).

A v. pancreaticoduodenalis cranialis was formed in 28 cases (93.3 %). In 12 cases (40.0 %), together with the v. gastroepiploica dextra, it was a tributary of the v. gastroduodenalis and in eight cases (26.7 %) it was an independent tributary of the v. portae. In two cases

(6.7 %) the two vv. pancreaticoduodenales united to form v. pancreaticoduodenalis communis. In three cases (10.0 %) this vein was duplicated and in one case it was triplicated.

A v. gastroepiploica dextra was found in 26 cases (86.7 %) and a v. gastroepiploica sinistra in 22 (73.3 %). Both veins occurred simultaneously in 19 cases (63.3 %). In no case, however, was there a continuous venous arc along the curvatura major ventriculi.

A v. lienalis was present in 28 cases (93.3 %). It was absent in two cases (6.7 %), in which it was replaced by inter-organ anastomoses with the stomach and pancreas. In 19 cases (63.3 %), the v. gastroepiploica sinistra and v. gastrica sinistra were both its main tributaries and in five cases (16.7 %) its main tributary was the v. gastrica sinistra. In one case the v. lienalis was duplicated.

Inter-organ anastomoses were formed in all 30 cases (100 %). They occurred between the spleen and the stomach in 27 cases (90 %) and between the spleen and the pancreas in 28 cases (93.3 %). Their number varied from one to five.

A v. pancreaticoduodenalis caudalis was observed in 28 cases (93.3 %). In the other two it was replaced by small vv. pancreaticae transporting blood to the v. lienalis. In 21 cases (70.0 %) it opened independently into the v. mesenterica cranialis.

A comparison of the morphology of the portal venous bed in the hamster, cat, guinea pig, rabbit and rat shows that the cat differs markedly from the other animals examined. The hamster, guinea pig (rodents) and rabbit (a lagomorph) display the greatest similarity, while the rat (a rodent) is rather different. Lagomorphs thus have several features in common with rodents – doubtless in association with their similar habits and food as against the habits and food of carnivores.

ABBREVIATIONS

a – anastomosis, c – v. cardiaca, gadu – v. gastroduodenalis, gepd – v. gastroepiploica dextra, geps – v. gastroepiploica sinistra, d – v. duodenalis, l – v. lienalis, mcr – v. mesenterica cranialis, p – v. portae, pdca – v. pancreaticoduodenalis caudalis, pdco – v. pancreaticoduodenalis communis, pdcr – v. pancreaticoduodenalis cranialis, py – v. pylorica, vg – v. gastrica, vp – v. pancreatica.

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