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The retroperitoneal anastomoses of the gonadal veins in human foetuses

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In the retroperitoneal space the gonadal veins form a collateral circulation that has a great clinical impact on sclerotherapy or surgical ligation of varicoceles. The aim of this study was to examine the communications of the gonadal veins (according to classification, frequency of appearance, gender and syntopic differences) in human foetuses of both sexes (71 males and 59 females) aged 4–6 months of intrauterine life. On the right side the most frequently were found the gonadal-periureteral anastomosis (23%) and the gonadal-perirenal anastomosis (22%). A gonadal-lumbar anastomosis on the right side appeared in 7% of cases. On the left side the most frequent (37%) was the gonadal-perirenal anastomosis, more frequently occurring as an ovarian-perirenal anastomosis (48%) than as a testicular-perirenal anastomosis (29%). Gonadal-periureteral anastomoses were found in a quarter of cases. Gonadal-lumbar anastomoses were observed in 7% of individuals. On the left side the gonadal-mesenteric inferior anastomosis was specifically observed (21%) as an ovarian-mesenteric inferior anastomosis (24%) and a testicular-mesenteric inferior anastomosis (19%). The cross-communications between the right and left gonadal veins (7%) were more frequently as the bilateral testicular (9.7%) than as the bilateral ovarian one (3%). In female foetuses gonadal-perirenal anastomoses occurred with statistically greater frequency than gonadal-periureteral anastomoses ($p \leq 0.05$). The frequency of cross-communications of the gonadal veins was three times greater in male foetuses ($p \leq 0.01$). Statistical analysis revealed a significantly greater frequency of left-sided anastomoses: the gonadal-perirenal in both sexes ($p \leq 0.05$), the gonadal-periureteral in males ($P \leq 0.05$) and the gonadal-mesenteric inferior in both sexes ($p \leq 0.01$).

Key words: testicular vein, ovarian vein, venous communication, human foetuses

INTRODUCTION

The deep veins from the testicle and epididymis form the pampiniform plexus, which is drained superiorly by three or four veins that pass through the inguinal canal, terminate on each side in two testicular veins at the deep inguinal ring, and ascend with the testicular artery [20]. The ovarian veins form a plexus near the ovary and uterus. Two ovarian veins emerge from this plexus, leave the mesovarium through the suspensory ligament and lie next to the

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Table 1. Classification and frequency of appearance of anastomoses of the gonadal veins according to different authors

Side of body	Type of anastomosis	Frequency of appearance (%)				
		Wishahi	Sofikitis	Bensussan	Bigot	Riedl
Right	Gonadal-perirenal	100	–	–	–	–
	Gonadal-periureteral	–	–	8	7.8–8	54.7
	Gonadal-mesenteric inferior	–	–	37	37–39	–
	Gonadal-lumbar	–	–	8	7.7–8	70.1
Left	Gonadal-perirenal	76	–	–	–	–
	Gonadal-periureteral	100	49	–	15	54.7
	Gonadal-mesenteric inferior	76	39	–	9.2–45	–
	Gonadal-lumbar	–	39	40	40	70.1
Right-left	Bilateral gonadal	55	4	–	2–3	16.8

ovarian artery. The testicular and ovarian veins are discussed together as "the gonadal veins" [1, 10, 13, 19]. The left gonadal veins join the left renal vein at right angles, and the right gonadal veins open the inferior *vena cava*. The gonadal veins communicate with other retroperitoneal veins at the level of the iliac crest, with the paravertebral lumbar, with the colic veins and with the capsular renal and ureteric veins. The visceral-gonadal shunts play a very important role because they form a collateral circulation in the retroperitoneal space and have a great clinical impact on sclerotherapy or surgical ligation of varicoceles [6, 7, 9, 10, 17, 18]. In the professional literature there are major differences regarding the frequency of appearance of anastomoses of the gonadal veins (Table 1). According to cumulative statistics, they have been identified most frequently (89.5–92%) in the proximal part of the gonadal veins, more rarely (56.7–81%) in the middle part, and most rarely (51.2%) in the distal part [1, 6, 12, 14]. The retroperitoneal anastomoses of the gonadal veins in human foetuses have not previously been described. The objective for the present research was to examine, on the basis of data in the available literature, the communications of the gonadal veins, taking into consideration their frequency of appearance, classification, gender and syntopic differences.

MATERIAL AND METHODS

The examinations were performed on 130 human foetuses of both sexes (71 males and 59 females), aged 4–6 months of intrauterine life (Table 2), which had come from spontaneous abortions and premature deliveries. Anatomical examination was performed by conventional preparation of the veins using microsurgical tools and a stereoscope with Huygen's ocular, at a magnification of 25–50 times. The whole tree of the gonadal vein was prepared, from the origin to the termination, with its anastomoses joining the retroperitoneal veins. The anastomoses of the gonadal veins were analysed, taking into consideration the sex of the foetus and the side of body. For examination of gender and syntopic differences the Student's t test for two independent variables was used.

Table 2. Age and sex of investigated foetuses

Foetal age		Number	Sex	
Month	Hbd-life		Male	Female
4	15	24	11	13
	16	44	33	11
5	17	9	6	3
	18	9	4	5
	19	9	5	4
	20	19	10	9
6	20	10	1	9
	22	6	1	5
	Total	130	71	59

RESULTS

In the retroperitoneal space many anastomoses of the gonadal veins were found (Fig. 1–3). These were formed by the gonadal veins with the perirenal veins (gonadal-perirenal anastomosis), with the periureteral veins (gonadal-periureteral anastomosis) and with the lumbar veins (gonadal-lumbar anas-

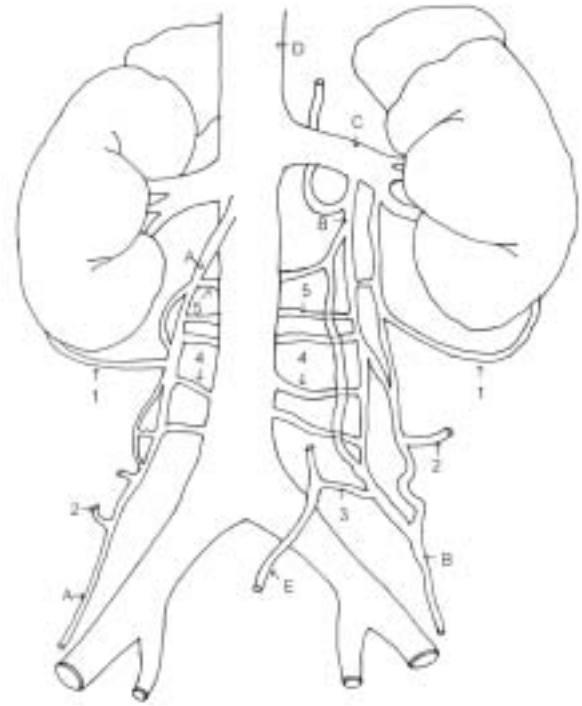

Figure 1. Schema of the anastomoses of the gonadal veins: A — right gonadal vein, B — left gonadal vein, C — left renal vein, D — inferior vena cava, E — inferior mesenteric vein, 1 — gonadal--perirenal anastomosis, 2 — gonadal-periureteral anastomosis, 3 — gonadal-mesenteric inferior anastomosis, 4 — gonadal--lumbar anastomosis, 5 — bilateral gonadal anastomosis.

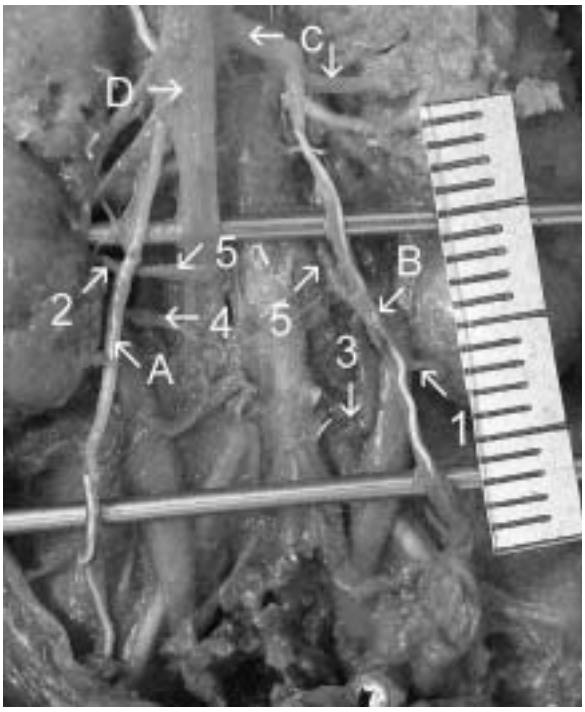

Figure 3. Anastomoses of the gonadal veins: A — right gonadal vein, B — left gonadal vein, C — left renal vein, D — inferior *vena cava*, 1 — gonadal-perirenal anastomosis, 2 — gonadal--periureteral anastomosis, 3 — gonadal-mesenteric inferior anastomosis, 4 — gonadal-lumbar anastomosis, 5 — bilateral gonadal anastomosis.

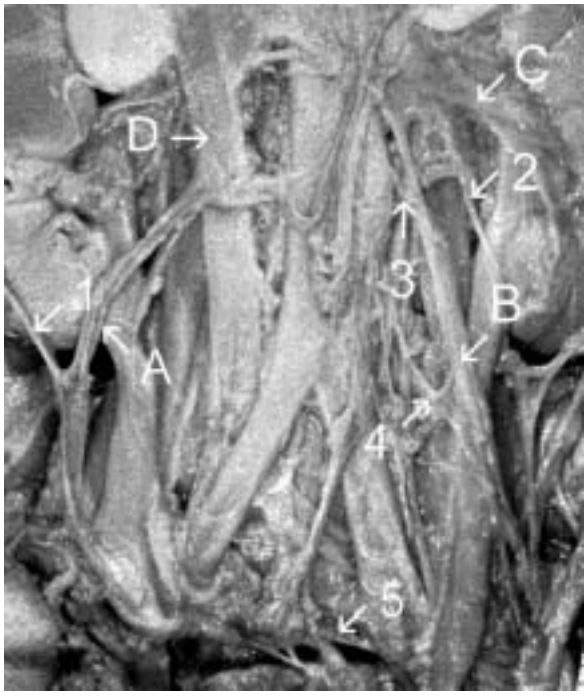

Figure 2. Anastomoses of the gonadal veins: A — right gonadal vein, B — left gonadal vein, C — left renal vein, D ——inferior *vena cava*, 1 — gonadal-perirenal anastomosis, 2 — gonadal--periureteral anastomosis, 3 — gonadal-mesenteric inferior anastomosis, 4 — gonadal-lumbar anastomosis, 5 — bilateral gonadal veins anastomosis.

tomosis) and cross-communications between the right and left gonadal veins (bilateral gonadal anastomosis). Anastomoses of the gonadal veins in both sexes are shown separately for the right (Table 3) and the left (Table 4) sides of the body. On the right side the most frequent (23% of cases) were either the gonadal-periureteral anastomosis, in 31% as the ovarian-periureteral anastomosis and in 17% as the testicular-periureteral anastomosis, or the gonadal--perirenal anastomosis (22%), in 21% of cases as the testicular-perirenal anastomosis and in 24% as the ovarian-perirenal anastomosis ($p \leq 0.05$). Right gonadal-lumbar anastomoses were found as the testicular-lumbar (7.3%) and the ovarian-lumbar anastomosis (6.8%). On the right side anastomoses of the gonadal veins with the inferior mesenteric vein were absent. On the left side the most frequently occurring (37%) was the gonadal-perirenal anastomosis, more often as the ovarian-perirenal anastomosis (48%) than as the testicular-perirenal anastomosis (29%), ($p \leq 0.05$). In a quarter of the cases in the studied material gonadal-periureteral anastomoses were observed as an ovarian-periureteral anastomosis (27%) and a testicular-periureteral anastomosis (24%). Gonadal-lumbar anastomoses were

Table 3. Anastomoses of the right gonadal veins

Type of anastomosis	Male		Female		Male and female	
	n	%	n	%	n	%
Gonadal-perirenal anastomosis	15	21	14	24	29	22
Gonadal-periureteral anastomosis	12	17	18	31	30	23
Gonadal-lumbar anastomosis	5	7.3	4	6.8	9	7
Bilateral gonadal anastomosis	7	9.7	2	3.5	9	7

Table 4. Anastomoses of the left gonadal veins

Type of anastomosis	Male		Female		Male and female	
	n	%	n	%	n	%
Gonadal-perirenal anastomosis	20	29	28	48	48	37
Gonadal-periureteral anastomosis	17	24	15	27	32	25
Gonadal-mesenteric inferior anastomosis	13	19	14	24	27	21
Gonadal-lumbar anastomosis	5	7	5	7	10	7
Bilateral gonadal anastomosis	7	9.7	2	3.5	9	7

found equally frequently in both sexes as the testicular--lumbar anastomosis (7%) and the ovarian-lumbar anastomosis (7%). In contrast to the right side, left--sided gonadal-mesenteric inferior anastomoses were observed in 21% of cases, as an ovarian-mesenteric inferior anastomosis (24%) and as a testicular-mesenteric inferior anastomosis (19%). The bilateral testicular anastomosis was more frequent (9.7%) than the bilateral ovarian one (3%). There were no cross-communications between the left and right testicular venous systems in the scrotal, retropubic and pelvic areas. The bilateral gonadal communications occurred in the lumbar area only. It must be emphasised that, in comparison to the anastomoses of the gonadal veins on both sides, the gonadal-perirenal anastomoses were more frequent on the left side and only the gonadal-mesenteric inferior anastomoses were found on the left side.

In female foetuses there was a statistically greater incidence of gonadal-perirenal and the gonadal--periureteral anastomoses ($p \leq 0.05$). Incidence of cross-communication of the gonadal veins was three times greater in male foetuses ($p \leq 0.01$). The statistical analysis presents a significantly greater incidence of left-sided anastomoses: gonadal-perirenal in both sexes ($p \leq 0.05$), gonadal-periureteral in males ($p \leq 0.05$) and gonadal-mesenteric inferior in both sexes ($p \leq 0.01$).

DISCUSSION

The subcardinal veins contribute to the formation of the left renal, adrenal and gonadal veins, and the segment of the inferior *vena cava*. The subcardinal veins are connected with the supracardinal and the vitelline veins by multiple anastomotic channels, which form retroperitoneal venous communications. The anastomoses of the gonadal veins form the basis for collateral circulation with the perirenal, periureteral, inferior mesenteric and the contralateral gonadal veins, and also with the renal veins and the inferior *vena cava* in the retroperitonel space [4–10, 15–17, 20]. In men these communications are important in the management of varicocele and infertility. The persistence of these venous anastomoses may be responsible for recurrent varicoceles after embolisation or surgical ligation. Percutaneous sclerotherapy could be optimised when performed caudally to these communications [4].

The communications of the gonadal veins observed in the foetal material under examination have been described earlier in adult men. Gonadal--periureteral anastomosis on the right side was also found in 8% in the studies of Bigot et al. [2, 3, 5] and of Bensussan and Huguet [1], although the figure was 41% in the material of Riedl at al. [14]. Our findings confirm the presence of right gonadal-periureteral anastomoses in 23% (17% in males and 31% in

females), which would indicate that it is not as common as shown in the literature concerning adults. The presence of the gonadal-periureteral anastomoses on the left side was confirmed constantly by Wishahi [18] but by Riedl [12, 13] in 54.7%, by Sofikitis et al. [17] in 49%, by Bensussan and Huguet [1] in 19%, and by Bigot and Chatel [3] in 15% of cases. In our material these communications were found in 25% (24% in males and 27% in females). Anastomoses of the gonadal veins with the perirenal veins were observed constantly on the right side in the autopsy material of Wishahi [20] and in 76% of individuals on the left side. The testicular veins, midway between the deep inguinal ring and the lower pole of the kidney, divided into the medial and the lateral branch to form a delta. The medial branch joined the inferior *vena cava* on the right side and the renal vein on the left side. The lateral branch communicated with colonic and renal capsular veins and terminated in the perinephric space, as the so-called "colotesticular-ureteric venous channel". In the present work gonadal-perirenal anastomoses were observed on the right side in 22% (21% in males and 24% in females) and on the left side in 37%, more frequently in females (48%) than in males (29%). On radiographic study, Bensussan and Huguet [1] and Bigot et al. [2, 5] found that anastomoses of the right gonadal veins with the lumbar veins occurred in 7–8%, a similar percentage to that in our material (7.3% in males and 6.8% in females). These observations do not correlate with the radiographic results of Riedl et al. [14], where gonadal-lumbar anastomoses were found in 70.1%. The anastomoses of the gonadal veins with the lumbar veins were confirmed by Sofikitis et al. [17] in 39%, by Bensussan and Huguet [1] and by Bigot et al. [4] in 40%, and by Riedl [13] in 70.1% of individuals. In our examination gonadal-lumbar anastomoses were found only in 7% of male foetuses. The gonadal-mesenteric inferior anastomosis on the right side was found in 37–39% of cases in the materials of Bensussan and Huguet [1] and of Bigot et al. [4]. In our material the gonadal--mesenteric inferior anastomoses on the right side were absent. Similar observations concerning the absence of the right gonadal-mesenteric inferior anastomoses were made by Riedl [13]. The presence of gonadal-mesenteric inferior anastomoses on the left side was observed by Bensussan and Huguet [1] in 45% of cases, by Sofikitis et al. [17] in 39%, and by Bigot et al. [4] in only 9.2% of the examined material. In the foetal material under examination gonadal-mesenteric inferior anastomoses were observed only on the left side in 21% of foetuses (19% in males, 24% in females). Bilateral gonadal anastomoses were found more frequently in the supra-inguinal (4–55%) than in the infra-inguinal part (3–24%) [18–20]. According to some authors [1, 11], bilateral gonadal anastomoses were absent in both supra-inguinal and infra-inguinal parts. We observed bilateral gonadal anastomoses in 7% of cases, more frequently in males (9.7%) than in females (3.5%). The cross-communications between the bilateral testicular veins were seen only in the supra-inguinal part. This fact has been confirmed by Wishahi [18] in an autopsy, radiographic and operative series of 30, 28 and 7 adult males. The gender differences, observed by us, concerning the statistically greater frequency of both the gonadal-perirenal and gonadal-periureteral anastomoses in female foetuses ($p \leq 0.05$) and the bilateral gonadal anastomoses in male foetuses ($p \leq 0.01$), have not previously been discussed in the literature. The statistical analysis revealed a significantly greater frequency of left-sided anastomoses: gonadal-perirenal in foetuses of both sexes ($p \leq 0.05$), gonadal-periureteral in males ($p \leq 0.05$) and gonadal-mesenteric inferior in both sexes ($p \leq 0.01$). These syntopic differences, with a predominance of left retroperitoneal anastomoses observed in foetal material, are confirmed by Wishahi [18–20] in adults.

Bigot et al. [4] described a very rare anastomosis between the left testicular and splenic vein in men with recurrent varicocele. The presence of the different anastomoses between the gonadal and visceral veins indicates the necessity for attentive identification of all these communications during surgical treatment of varicocele. Our findings and data from the professional literature show the great individual variability of the anastomoses of the gonadal veins in respect of frequency of appearance. The differences between the data of other researchers and our observations result primarily from the different methods used in examinations and from the material under investigation. It is necessary to note that the majority of authors [1–4, 9, 10, 14, 19] carried out only radiographic studies, without preparation of the gonadal veins. The present work reveals imperfections in the radiographic method in the detection of the retroperitoneal anastomoses of the gonadal veins, the exact identification of which is possible only intra-operatively or through anatomical dissection. Generally, the results of other scientists demonstrate that the anastomoses of the gonadal veins occur most frequently on the left side in adult men with varicocele than in the foetal material under examination. Varicocele, which is almost always on the

left side, is perhaps due to the orthogonal junction of the left testicular and renal veins, and to the fact that the superior mesenteric artery crosses and partially compresses the left renal vein just before its termination, causing an increase in hypertension in the left venous testicular tree. In our opinion the number of collaterals of the gonadal veins is closely related to the venous insufficiency of the testicular tree in patients with varicocele. An increase in hypertension in the testicular venous tree in patients with varicocele stimulates the development of the collateral pathways and the formation of the secondary venous system [7].

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