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Skeletopic analysis of the gonadal veins in human foetuses

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*During ontogenesis an imbalance is observable in the development of the skeletal and vascular systems. By means of anatomical and radiological methods the gonadal veins were studied in relation to the vertebral column in 60 human foetuses of both sexes aged from 4 to 6 months of prenatal life. In male foetuses aged 4–5 months the origin of the gonadal veins projected onto the sacral apex ($r_1 = 0.95$, $r_3 = 0.85$), and in 6th month they extended below the vertebral column ($r_{1'} = 0.80$, $r_{3'} = 0.90$). In female foetuses the origin of the gonadal veins in the 4th month projected symmetrically onto S_1 ($r_5 = 0.70$, $r_7 = 0.70$). In the 5th month of intrauterine life the origin of the left ovarian vein was found at S_2 ($r_{7'} = 0.80$) and the origin of the right one at S_1–S_2 ($r_{5'} = 0.80$). In the 6th month the origin of the left ovarian vein was located at S_3 ($r_{7''} = 0.80$) and the right one at S_2–S_3 ($r_{5''} = 0.90$). The skeletopic analysis of the origin of the gonadal veins demonstrated gender (the origin was higher in females) and syntopic (the origin was higher on the right side) differences ($p \leq 0.05$). In foetuses of both sexes aged 4 months of prenatal life the termination of the left gonadal veins projected onto Th_{12}–L_1 ($r_4 = 0.85$, $r_8 = 0.80$) and in foetuses aged 5–6 months it projected onto L_1–L_2 ($r_{4'} = 0.90$, $r_{8'} = 0.95$). In both sexes the termination of the gonadal veins on the right side projected constantly onto L_2 ($r_2 = 0.90$, $r_6 = 0.95$) from the 4th to the 6th month of intrauterine life. The skeletopic analysis of the termination of the gonadal veins showed syntopic dimorphism ($p \leq 0.05$) without gender differences ($p > 0.05$). On the right side the termination of the gonadal (testicular and ovarian) veins projected constantly onto L_2. On the left side the termination of the left gonadal (testicular and ovarian) veins apparently descended by one vertebra (*pseudodescensus*).*

Key words: gonadal veins, skeletopic age correlation coefficient, human foetuses

INTRODUCTION

The radiographic study of Bigot and coauthors [5–8] reveals that the termination of the right testicular vein is located at the level of the 2nd and 3rd lumbar vertebrae (L_2–L_3). It projects most frequently onto the transverse process of L_2 (46%) or onto the intervertebral space L_2–L_3 (29%). In the remainder (25%) the termination of the right gonadal vein projects onto the body of L_1–L_2 or onto the transverse process of L_3. According to Kadir's statistics [13], the termination of the gonadal veins projects most frequently onto the body of L_1. During ontogenesis slowly developing vessels

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do not keep pace with the intensively dynamic development of the cranial and caudal elongations of the vertebral column [12, 14, 15]. The developmental relations of the gonadal veins and vertebral column in human foetuses have not previously been reported.

The aim of this study was to examine:

— the location of the gonadal veins in relation to the vertebral column on the basis of projections of their origin and termination;
— the skeletopic correlation coefficients of the origin and termination of the gonadal veins in relation to foetal age (skeletopic age correlation coefficient);
— the influence of sex and side of body on the skeletopic position;
— the skeletopic trend of the gonadal veins during foetal development.

MATERIAL AND METHODS

The research material consisted of 60 human foetuses (30 male and 30 female) aged from 4 to 6 months of intrauterine life, classified so that 10 foetuses of each sex fell into each of three age groups (Table 1). The foetuses were obtained from spontaneous abortion as well as premature parturition. The gonadal veins were prepared using the conventional anatomical method under a stereoscope with Huygens ocular. We selected foetuses with the most frequent pattern, where the left gonadal vein joined the renal vein and the right one joined the inferior vena cava (IVC). The location of the gonadal veins in relation to the vertebral column was marked with pins inserted at the origin and termination of a vessel. Using Unipan 401 apparatus, radiograms were made in posterior-anterior position. The relations of the gonadal veins on the vertebral column were defined on the radiograms. The results were statistically described on the basis of Student's t test for two mean dependent variables (developmental dynamic) and Student's t test for two mean independent variables (gender and syntopic dimorphisms). Skeletopic age correlation coefficients (r) of the gonadal veins were also determined.

RESULTS

In male foetuses at the age of 4–5 months of prenatal life the origin of the gonadal veins (the right and left testicular veins) projected onto the sacral apex ($r_1 = 0.95$, $r_3 = 0.85$), while in 6th month this was below the vertebral column ($r_{1'} = 0.80$, $r_{3'} = 0.90$) (Table 1). In female foetuses the origin of the gonadal veins (the right and left ovarian veins) in the 4th month of intrauterine life projected symmetrically onto S_1 ($r_5 = 0.70$, $r_7 = 0.70$) but in foetuses aged 5–6 months the left ovarian vein projected a little lower than the right one. In the 5th month of intrauterine life the origin of the left ovarian vein was found at S_2 ($r_{7'} = 0.80$) and the origin of the right one was found at S_1–S_2 ($r_{5'} = 0.80$). In the 6th month of intrauterine life the origin of the left ovarian vein was located at S_3 ($r_{7''} = 0.80$) and the right one at S_2–S_3 ($r_{5''} = 0.90$). The skeletopic analysis of the origin of the gonadal veins demonstrated gender (the origin was higher in females) and syntopic (the origin was higher on the right side) differences ($p \leq 0.05$).

In foetuses of both sexes aged 4 months of prenatal life the termination of the left gonadal veins projected onto Th_{12}–L_1 ($r_4 = 0.85$, $r_8 = 0.80$) and in foetuses aged 5–6 months it projected onto L_1–L_2 ($r_{4'} = 0.90$, $r_{8'} = 0.95$) (Fig. 1). In both sexes the termination of the gonadal veins on the right side pro-

Table 1. Skeletopy of the gonadal veins in foetuses (skeletopic age correlation coefficient — in brackets)

Sex	Age of foetuses (months)	Number of foetuses (n)	Projection on the vertebral column			
			Right gonadal vein		Left gonadal vein	
			Origin	Termination	Origin	Termination
Male	4	10	The sacral apex ($r_1 = 0.95$)	L_2 ($r_2 = 0.90$)	The sacral apex ($r_3 = 0.85$)	Th_{12}–L_1 ($r_4 = 0.85$)
	5	10	The sacral apex ($r_1 = 0.95$)	L_2 ($r_2 = 0.90$)	The sacral apex ($r_3 = 0.85$)	L_1–L_2 ($r_{4'} = 0.95$)
	6	10	Below the vertebral column ($r_{1'} = 0.80$)	L_2 ($r_2 = 0.90$)	Below the vertebral column ($r_{3'} = 0.90$)	L_1–L_2 ($r_{4'} = 0.95$)
Female	4	10	S_1 ($r_5 = 0.70$)	L_2 ($r_6 = 0.95$)	S_1 ($r_7 = 0.70$)	Th_{12}–L_1 ($r_8 = 0.80$)
	5	10	$S_{1\text{-}2}$ ($r_{5'} = 0.80$)	L_2 ($r_6 = 0.95$)	S_2 ($r_{7'} = 0.80$)	L_1–L_2 ($r_{8'} = 0.95$)
	6	10	$S_{2\text{-}3}$ ($r_{5''} = 0.90$)	L_2 ($r_6 = 0.95$)	S_3 ($r_{7''} = 0.80$)	L_1–L_2 ($r_{8'} = 0.95$)

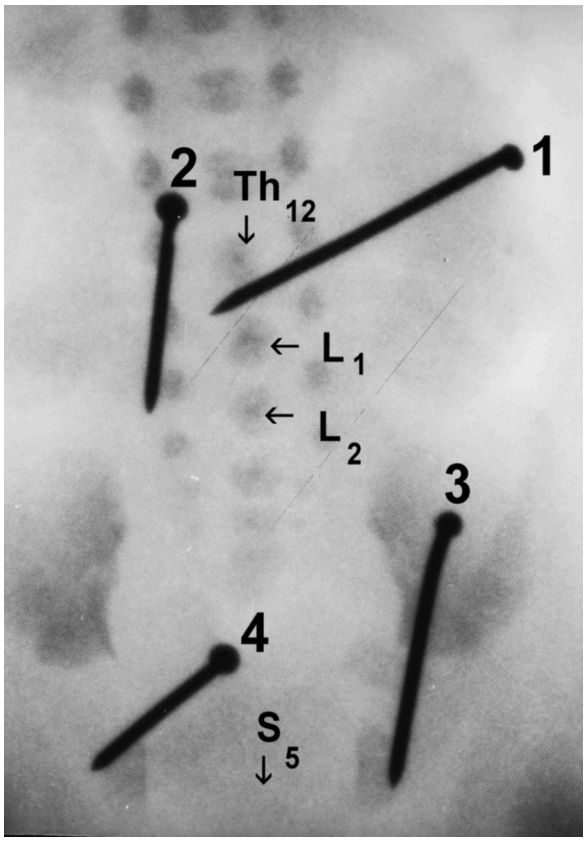

Figure 1. The points of pins for skeletopy of the testicular veins in human foetuses at the 4th month: 1 — termination of the left testicular vein, 2 — termination of the right testicular vein, 3 — origin of the left testicular vein, 4 — origin of the right testicular vein.

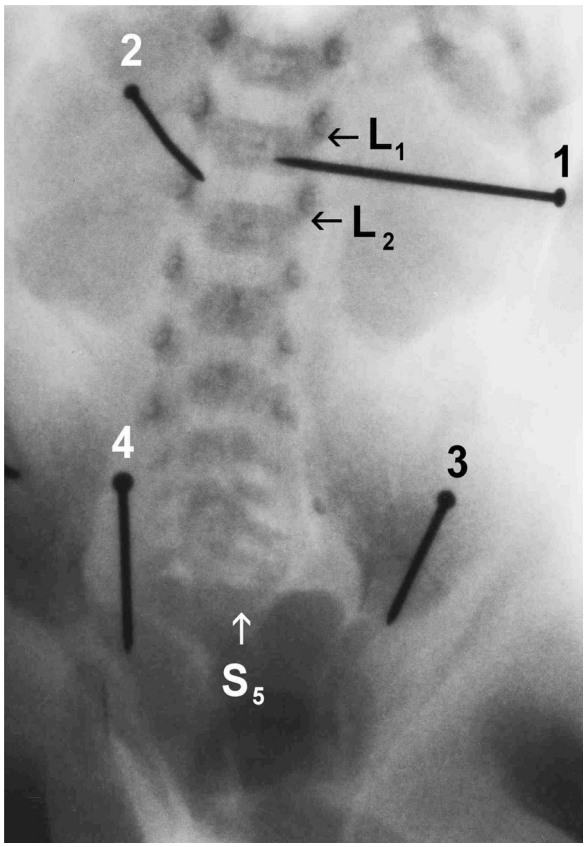

Figure 2. The points of pins for skeletopy for the testicular veins in human foetuses at the 6th month: 1 — termination of the left testicular vein, 2 — termination of the right testicular vein, 3 — origin of the left testicular vein, 4 — origin of the right testicular vein.

jected constantly onto L_2 ($r_2 = 0.90$, $r_6 = 0.95$) from the 4th to the 6th month of intrauterine life (Fig. 2). The skeletopic analysis of the termination of the gonadal veins showed syntopic dimorphism ($p \leq 0.05$) without gender differences ($p > 0.05$).

The highest values of skeletopic correlation coefficients in relation to age were found for the origin of the right testicular veins in foetuses aged 4–5 months ($r_1 = 0.95$) and terminations of either the right ovarian vein in foetuses aged 4–6 months ($r_6 = 0.95$) or the left testicular ($r_{4'} = 0.95$) and ovarian ($r_{8'} = 0.95$) veins in foetuses aged 5–6 months.

The lowest values of skeletopic age correlation coefficients were noted for the origin of the ovarian veins in foetuses aged 4 months ($r_5 = 0.70$, $r_7 = 0.70$).

The skeletopic analysis of the gonadal veins in foetuses aged 4–6 months showed an unequal developmental trend, with differences for their origin and termination (Table 1). In male foetuses aged 4–5 months the origin of the testicular veins projected onto the sacral apex but in the 6th month their origin moved below the vertebral column. The origin of the ovarian veins in the 4th month projected onto S_1 but in the 6th month it moved onto S_3 (the left ovarian vein) or S_2–S_3 (the right ovarian vein). On the right side the termination of the gonadal (testicular and ovarian) veins projected constantly onto L_2 in the age range examined. On the left side the termination of the left gonadal (testicular and ovarian) veins apparently descended by one vertebra (*pseudodescensus*). In the 4th month the termination of the left gonadal veins was found at Th_{12}–L_1 but in foetuses aged 5–6 months it projected onto L_1–L_2.

DISCUSSION

Data from the professional literature describe the skeletopy of the testicular veins in adults only [5–8, 13, 16]. The present observations prove that in foetuses aged 4–6 months the termination of the right gonadal veins in both sexes projected constantly onto L_2. On the other hand, the termination of the left gonadal veins projected differently and between the 4th and 6th months of intrauterine life it descended by one vertebra. In the 4th month the termination of

the left gonadal left was situated at Th_{12}–L_1 and in the 5th month it projected onto L_1–L_2, also establishing this location in the 6th month of intrauterine life. These observations correspond exactly to the skeletopy of the termination of the gonadal veins in adults [3, 11, 18]. Ahlberg et al. [3], Giacchetto et al. [11] and Wishahi [18] found that in adults the termination of the right gonadal vein projects onto the body of the 2nd lumbar vertebra but that the termination of the left gonadal vein oscillates within the 1st and 2nd lumbar vertebrae. We consider that the terminations of the gonadal veins finally establish this position in the 6th month of prenatal life.

It is our view that characterisation of the gonadal veins is significantly supplemented by skeletopic age correlation coefficients. A comparison of skeletopic age correlation coefficients testifies indirectly to the variability of their location [15]. The origins of the right testicular veins in foetuses aged 4–5 months ($r_1 = 0.95$) and the terminations of either the right ovarian vein in foetuses aged 4–6 months ($r_6 = 0.95$) or the left testicular and ovarian veins in foetuses aged 5–6 months ($r_{4'} = 0.95$, $r_{8'} = 0.95$) are the most stable points. On the other hand, the origin of the ovarian veins in foetuses aged 4 months ($r_5 = 0.70$, $r_7 = 0.70$) is characterised by the greatest variability.

The stable level of the projection of the termination of the right gonadal vein onto the 2nd lumbar vertebra results from the synchronous development of the vertebral column and the segment of the IVC, which join the right gonadal vein (which could be termed "the gonadal segment of the IVC"). In the skeletopic sense this segment may be termed the "zero segment of the IVC", as it does not seem to ascend and descend, but maintains a stable position in relation to the vertebral column at the level of the 2nd lumbar vertebra. According to this original hypothesis, the part of the IVC (together with inflows) below the "zero segment of the IVC" does not keep pace with the caudal elongation of the vertebral column and apparently ascends (*pseudoascensus*) (Fig. 3). The part of the IVC above the "zero segment of the IVC" does not keep pace with the cranial elongation of the vertebral column, and apparently descends. In addition, the apparent descent concerns the renal veins, especially the left renal vein, which joins the left gonadal vein. This is confirmed by our studies, as in both sexes the terminations of the left gonadal veins in foetuses between the 4th and 5th months of prenatal life descended by one vertebra, from Th_{12}–L_1 to L_1–L_2. The apparent descent of the left gonadal vein was not even prevented by

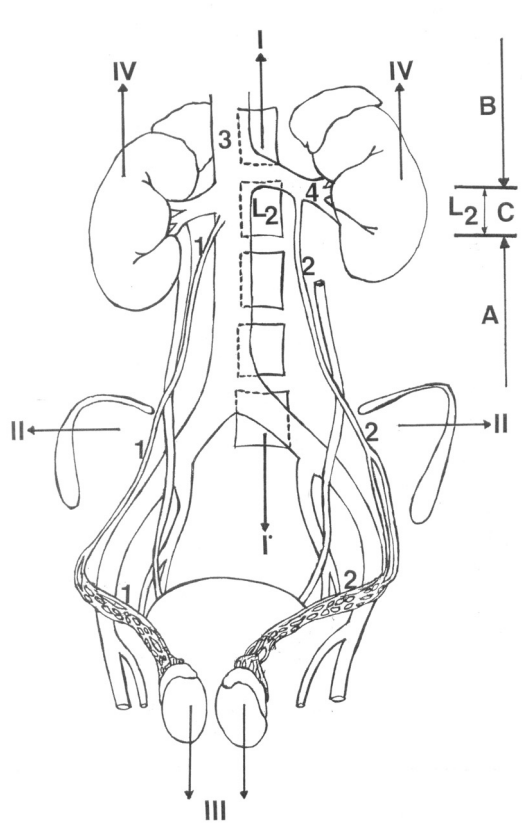

Figure 3. Developmental dynamic of the gonadal veins:
A — apparent ascent (*pseudoascensus*), B — apparent descent (*pseudodescensus*), C — "zero segment of the IVC", I — cranial elongation of the vertebral column, I' — caudal elongation of the vertebral column, II — extension of the transverse measurement of the pelvis, III — descent of the gonads, IV — cranial migration of the kidney; 1 — right gonadal artery, 2 — left gonadal artery, 3 — inferior vena cava (IVC), 4 — left renal vein.

the cranial migration of the left kidney, with which the apparent ascent of the left gonadal vein was coupled [1–4, 17, 18]. The apparent descent by one vertebra of the termination of the left gonadal vein that was observed in this work should be treated as an average of the apparent descent, resulting from developmental differences of the vertebral column and the IVC, decreased by the apparent ascent of the termination, which was caused by cranial migration of the kidney. It has been found that in the 4th month of intrauterine life the origins of both ovarian veins project onto S_1 but that in the 6th month the origin of the left ovarian vein projects onto S_3 and the right one onto S_2–S_3. In male foetuses at the age of 4–5 months of intrauterine life both testicular veins project onto the sacral apex and in the 6th month project below the vertebral column. This descent with its dependence on foetal age results from the active descent of the gonads [9–11, 13].

REFERENCES

1. Ahlberg NE, Bartley O, Chidekel N (1965) Circumference of the left gonadal vein. An anatomical and statistical study. Acta Radiol, 3: 503–512.
2. Ahlberg NE, Bartley O, Chidekel N (1965) Retrograde contrast filling of the left gonadal vein. A roentgenologic and anatomical study. Acta Radiol, 3: 385–392.
3. Ahlberg NE, Bartley O, Chidekel N (1966) Right and left gonadal veins. An anatomical and statistical study. Acta Radiol, 4: 593–601.
4. Ahlberg NE, Bartley O, Chidekel N, Frijofsson A (1966) Phlebography in varicocele scroti. Acta Radiol, 4: 517––528.
5. Bigot JM, Barret F, Helenon C (1982) Phlebography of the right spermatic vein in varicoceles. Varicocele and male infertility. Springer-Verlag, Berlin.
6. Bigot JM, Chatel A (1980) The value of retrograde spermatic phlebography in varicocele. Eur Urol, 6: 301–306.
7. Bigot JM, Le-Blanche AF, Corette MF, Gagey N, Bazot M, Boudghene FP (1997) Anastomoses between the spermatic and visceral veins: a retrospective study of 500 consecutive patients. Abdom Imaging, 22: 226–232.
8. Bigot JM, Utzmann O (1983) Right varicocele: contribution of spermatic phlebography. Results on 250 cases. J Urol, 89: 121–131.
9. Chatel A, Bigot JM, Barret F, Helenon C (1979) Veines spermatiques voies de suppleance. J Radiol, 60: 121–127.
10. Comhaire F, Kunnen M (1976) Selective retrograde venography of the internal spermatic vein: A conclusive approach to the diagnosis of varicocele. Andrologie, 8: 11–13.
11. Giacchetto C, Catizone F, Cotroneo GB (1989) Radiologic anatomy of the genital venous system in female patients with varicocele. Surg Gynecol Obstet, 169: 403–407.
12. Gościcka D, Szpinda M, Stankiewicz W (1995) Skeletopy of the common iliac arteries in human foetuses. Folia Morphol (Warsz), 54: 129–136.
13. Saadoon K (1991) Atlas of normal and variant angiograhic anatomy. WB Saunders Company, Philadelphia, pp. 259–267.
14. Szpinda M, Cieślińska-Wilk G, Szaflarska-Szczepanik A (1999) Projection of the renal arteries on vertebral column in human foetuses. Pol J Radiol, 64: 62–64.
15. Szpinda M, Flisiński P, Gościcka J (1999) Skeletopy of the brachiocephalic trunk and the common carotid arteries in human foetuses. Folia Morphol (Warsz), 58: 127–136.
16. Wishahi MM (1991) Anatomy of the venous drainage of the human testis: testicular vein cast, microdissection and radiographic demonstration. Eur Urol, 20: 154–160.
17. Wishahi MM (1992) Anatomy of the spermatic venous plexus (pampiniform plexus) in men with and without varicocele: intraoperative venographic study. J Urol, 147: 1285–1289.
18. Wishahi MM (1991) Detailed anatomy of the internal spermatic vein and the ovarian vein. Human cadaver study and operative spermatic venography: clinical aspects. J Urol, 145: 780–786.