

# Skeletopic analysis of the gonadal veins in human fetuses

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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 fetuses of both sexes aged from 4 to 6 months of prenatal life. In male fetuses 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 6<sup>th</sup> month they extended below the vertebral column ( $r_{1'} = 0.80$ ,  $r_{3'} = 0.90$ ). In female fetuses the origin of the gonadal veins in the 4<sup>th</sup> month projected symmetrically onto  $S_1$  ( $r_5 = 0.70$ ,  $r_7 = 0.70$ ). In the 5<sup>th</sup> 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 6<sup>th</sup> 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 fetuses 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 fetuses 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 4<sup>th</sup> to the 6<sup>th</sup> 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 fetuses

## 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 2<sup>nd</sup> and 3<sup>rd</sup> 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

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 fetuses 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 fetuses (30 male and 30 female) aged from 4 to 6 months of intrauterine life, classified so that 10 fetuses of each sex fell into each of three age groups (Table 1). The fetuses 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 fetuses 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.

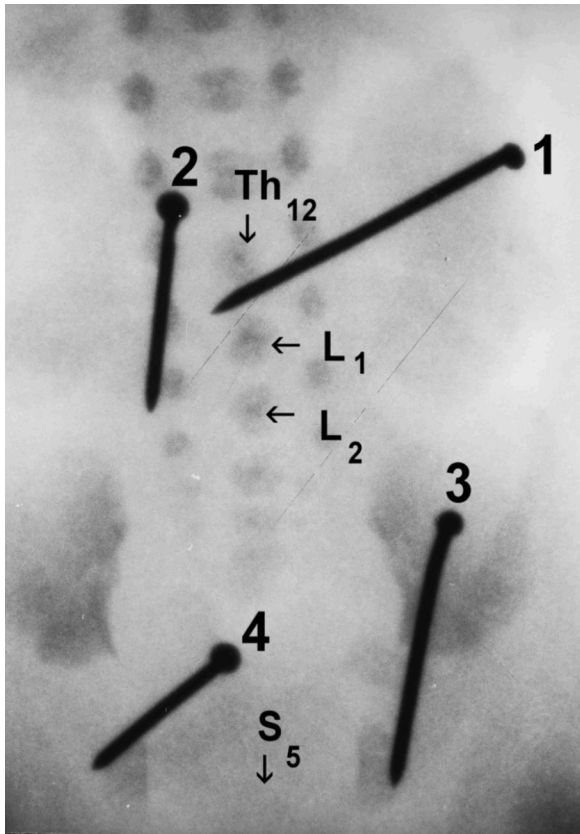
**RESULTS**

In male fetuses 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 6<sup>th</sup> month this was below the vertebral column ( $r_{1'} = 0.80$ ,  $r_{3'} = 0.90$ ) (Table 1). In female fetuses the origin of the gonadal veins (the right and left ovarian veins) in the 4<sup>th</sup> month of intrauterine life projected symmetrically onto  $S_1$  ( $r_5 = 0.70$ ,  $r_7 = 0.70$ ) but in fetuses aged 5–6 months the left ovarian vein projected a little lower than the right one. In the 5<sup>th</sup> 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 6<sup>th</sup> 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 ( $p \leq 0.05$ ).

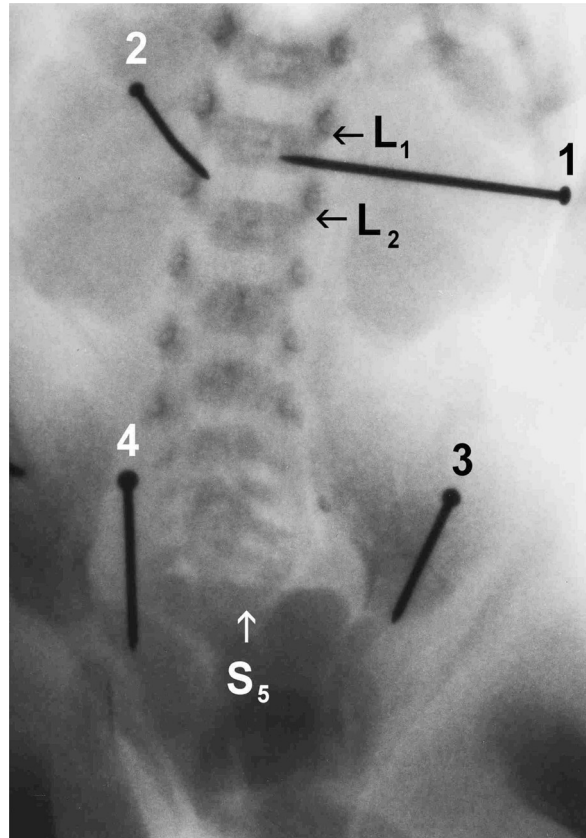
In fetuses of both sexes aged 4 months of prenatal life the termination of the left gonadal veins projected onto  $Th_{12}$ – $L_1$  ( $r_4 = 0.85$ ,  $r_8 = 0.80$ ) and in fetuses aged 5–6 months it projected onto  $L_1$ – $L_2$  ( $r_{4'} = 0.90$ ,  $r_{8'} = 0.95$ ) (Fig. 1). In both sexes the termination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

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

Sex	Age of fetuses (months)	Number of fetuses (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	$S_{1,2}$ ( $r_{5'} = 0.80$ )	$L_2$ ( $r_6 = 0.95$ )	$S_2$ ( $r_{7'} = 0.80$ )	$L_1$ – $L_2$ ( $r_{8'} = 0.95$ )
	6	10	$S_{2,3}$ ( $r_{5''} = 0.90$ )	$L_2$ ( $r_6 = 0.95$ )	$S_3$ ( $r_{7''} = 0.80$ )	$L_1$ – $L_2$ ( $r_{8'} = 0.95$ )



**Figure 1.** The points of pins for skeletopy of the testicular veins in human foetuses at the 4<sup>th</sup> 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 6<sup>th</sup> 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 4<sup>th</sup> to the 6<sup>th</sup> 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 6<sup>th</sup> month their origin moved below the vertebral column. The or-

igin of the ovarian veins in the 4<sup>th</sup> month projected onto  $S_1$  but in the 6<sup>th</sup> 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 4<sup>th</sup> 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  $L_1$ – $L_2$ .

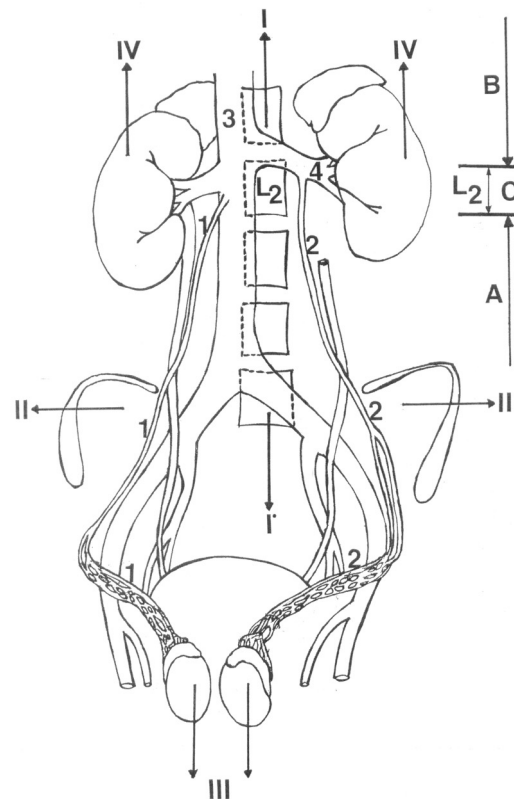
## DISCUSSION

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 4<sup>th</sup> and 6<sup>th</sup> months of intrauterine life it descended by one vertebra. In the 4<sup>th</sup> month the termination of

the left gonadal vein was situated at Th<sub>12</sub>–L<sub>1</sub> and in the 5<sup>th</sup> month it projected onto L<sub>1</sub>–L<sub>2</sub>, also establishing this location in the 6<sup>th</sup> 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 2<sup>nd</sup> lumbar vertebra but that the termination of the left gonadal vein oscillates within the 1<sup>st</sup> and 2<sup>nd</sup> lumbar vertebrae. We consider that the terminations of the gonadal veins finally establish this position in the 6<sup>th</sup> 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 2<sup>nd</sup> 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 2<sup>nd</sup> 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 4<sup>th</sup> and 5<sup>th</sup> months of prenatal life descended by one vertebra, from Th<sub>12</sub>–L<sub>1</sub> to L<sub>1</sub>–L<sub>2</sub>. 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 4<sup>th</sup> month of intrauterine life the origins of both ovarian veins project onto S<sub>1</sub> but that in the 6<sup>th</sup> month the origin of the left ovarian vein projects onto S<sub>3</sub> and the right one onto S<sub>2</sub>–S<sub>3</sub>. In male foetuses at the age of 4–5 months of intrauterine life both testicular veins project onto the sacral apex and in the 6<sup>th</sup> 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].

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