

# Development of valves in the small saphenous vein in human fetuses

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*The study was performed on 82 small saphenous veins in human fetuses of both sexes aged 9 to 37 weeks. The earliest valves were observed in 13 week-old fetuses. In fetuses between 13 and 18 weeks old the number of valves increased from 1 to 8. In the older fetuses between 19 and 37 weeks the number of valves varied from 5 to 9 and does not seem to be related to age. During development more valves were found in the upper part of the small saphenous vein. The height of valves increases with age and differs between particular valves of the same vein.*

**key words:** human development, venous valves, small saphenous vein

## INTRODUCTION

In 1628, Harvey described pathologic changes of venous valves and, in 1891, Trendelenburg indicated that venous valve insufficiency leads to the crural varices [12]. Chronic venous insufficiency may be caused by congenital or acquired changes of valves and walls of the superficial and deep veins. The great saphenous vein and the small saphenous vein are the main venous trunks and their usually paired valves occur at the same level along the length of the vein. In only a few cases have the unicuspid or tricuspid valves been described [3, 7, 8, 10, 11, 13, 14].

The number and location of valves in the small saphenous vein in human fetuses varies according to different authors [1, 3, 11]. The aim of the present study is to analyse the development of the valves in the small saphenous vein.

## MATERIAL AND METHODS

The study was performed on 82 small saphenous veins of human fetuses of both sexes (48 veins in male fetuses and 34 in female fetuses; 52 veins in the right lower limbs and 30 veins in the left lower limbs). The age of fetuses was between 9 and 37 weeks.

The lower limbs of the 9 to 10 week-old fetuses were embedded in paraplast and sectioned serially in the transverse plane.

The veins of the lower limbs in fetuses aged 11 to 37 weeks were dissected under stereomicroscope and with a magnifying lens. The length of the lower limb was measured from the greater trochanter to the lateral margin of the foot. The small saphenous vein was measured from the tip of lateral malleolus to its termination in the popliteal vein.

In fetuses aged 11 to 23 weeks the small saphenous veins were removed and embedded in paraplast and sectioned serially in transverse and longitudinal planes.

Histological sections 5  $\mu$ m thick were stained with hematoxylin and eosin. Number, height of valves, and distance between them were calculated from serial sections.

In fetuses between 24 and 37 weeks the investigated veins were cut longitudinally along the anterior aspect and the valves were inspected. The number, height and intervalvular distance were evaluated.

The results were analyzed statistically and were described with median line and minimum and maximum magnitudes. The Mann-Whitney test was used to compare the number of valves and the intervalvular

distance in the male and female veins and between the veins of the right and left limbs.

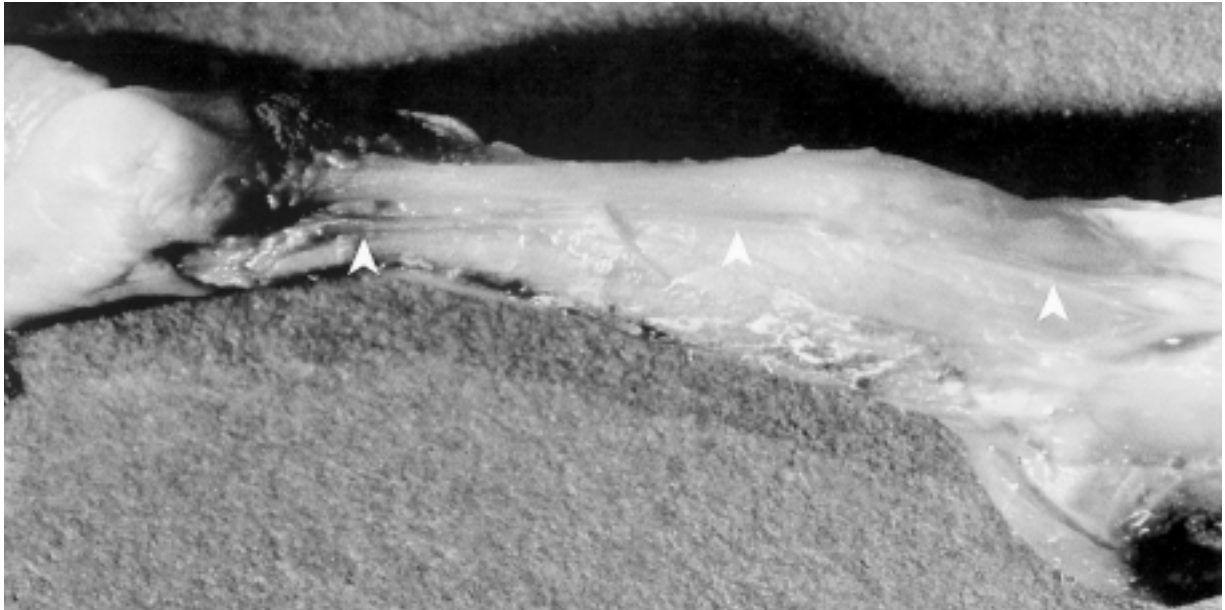
The relation between the number of valves and the age of the fetuses was determined using linear regression and a stabilization point.

The height of the valves in relation to the fetal age was determined using Spearman's correlation coefficient ( $r_s = 0.77$ ,  $p = 0.001$ ).

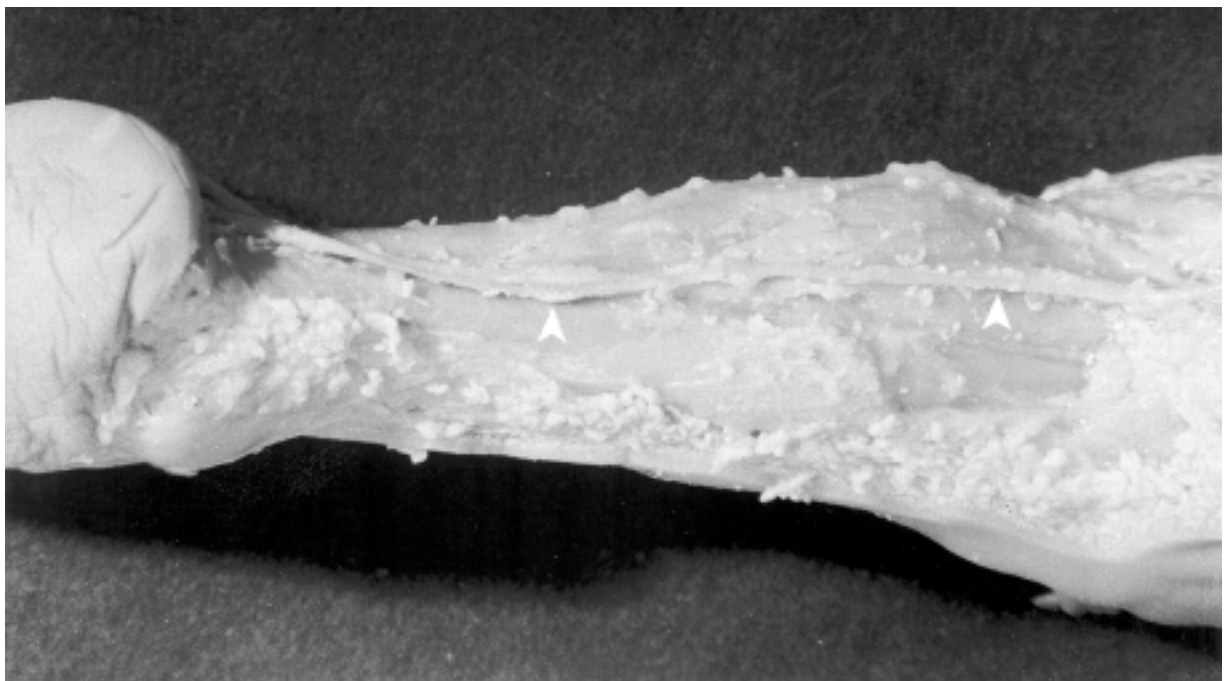
The hypotheses being tested were verified at the level of  $p = 0.05$ . The statistical packet STATISTICA version 5.5 was used to make the necessary calculations.

## RESULTS

In all investigated fetuses aged 11 to 37 weeks, the course of the small saphenous vein resembles that of adults (Fig. 1, 2). In three investigated cases,



**Figure 1.** The small saphenous vein (arrows) of a 12 week-old human fetus.



**Figure 2.** The small saphenous vein (arrows) of a 27 week-old human fetus.

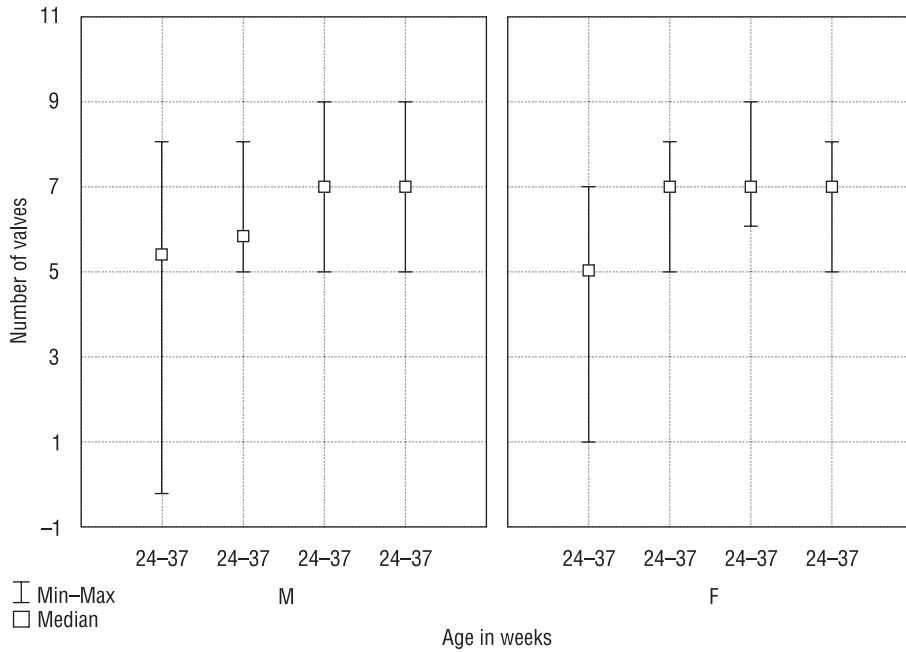
the small saphenous vein terminated in the deep, posterior femoral veins above popliteal fossa and in one case the small saphenous vein entered the great saphenous vein above the popliteal fossa.

The valves were first observed at 13 weeks. In fetuses of this age, the number of valves varies from 1 to 2, whereas in fetuses aged 37 weeks the number of valves were 5. In fetuses between 13 and 37

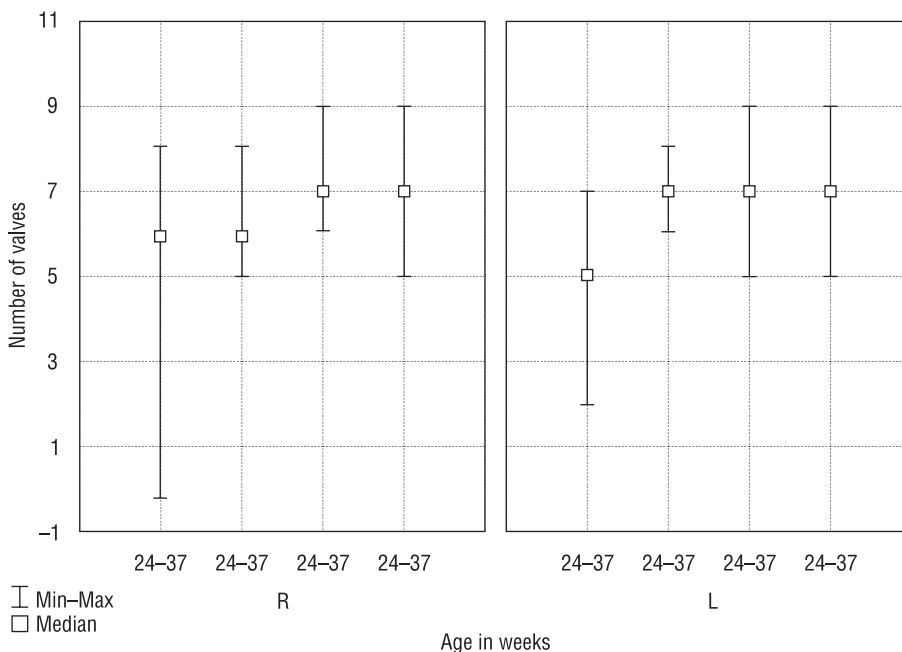
weeks, there was a maximum of 9 valves in the small saphenous. All valves were bicuspid.

There were no statistically significant differences in the number of valves between either the male and female fetuses (Fig. 3), and between the right and left limbs (Fig. 4).

Taking the relationship between the number of valves and age of the fetuses into consideration, it



**Figure 3.** The number of valves in the small saphenous vein in male (M) and female (F) fetuses.



**Figure 4.** The total number of valves in the right (R) and left (L) small saphenous veins.

was found that in fetuses aged 13 to 18 weeks, this number increases from 1 to 8, whereas in fetuses from 19 to 37 weeks old, the number of valves is rather stable and varies from 5 to 9. This was evident in the statistical analysis (Fig. 5). The number of valves stabilizes at 19<sup>th</sup> week.

The valves were observed along the whole length of the vein, and they are not distributed regularly. In distances between valves in the fetuses aged 13 to 18 weeks old were from 0.5 mm to 9.9 mm, whereas such distances varied from 0.7 mm to 18 mm in fetuses 19 weeks old and old. It was observed that the

valves were located predominantly in the upper parts of the veins (Fig. 6–8).

It was also shown that the height of the valves increases with the fetus' age (Spearman's correlation coefficient of  $r_s = 0.77$ ,  $p. < 0.001$ ) (Fig. 9).

The valves were at various stages of development in given veins of the same age.

### DISCUSSION

In serial sections, the early valves were observed as a condensation of endothelium and underlying mesenchyme gradually acquiring semilunar shape.

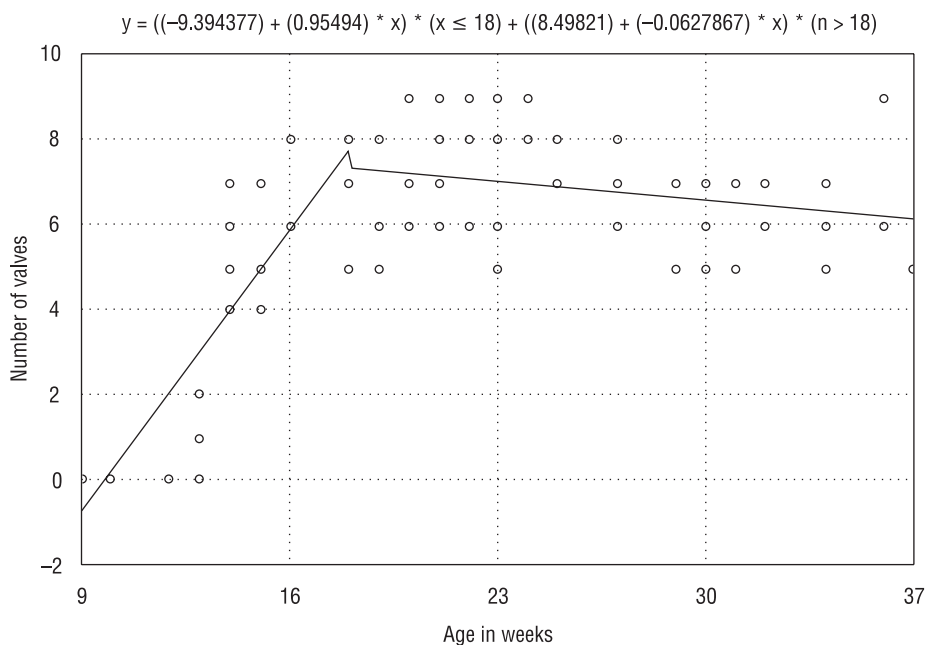


Figure 5. The number of valves in the small saphenous vein in relation to the age of the fetuses.

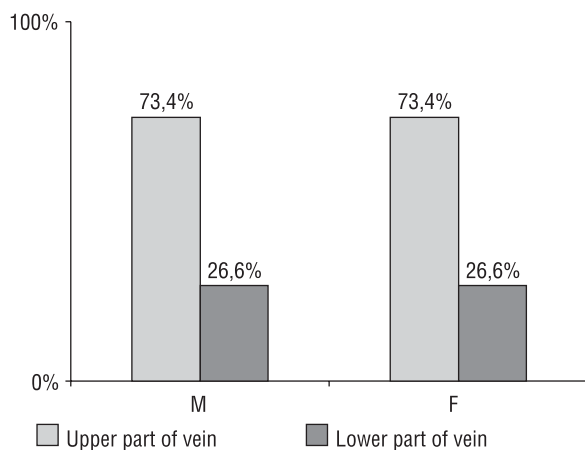


Figure 6. The distribution of valves in the small saphenous veins of male (M) and female (F) fetuses.

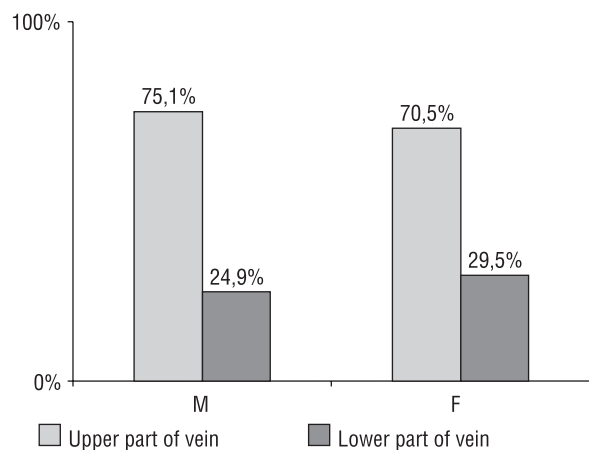
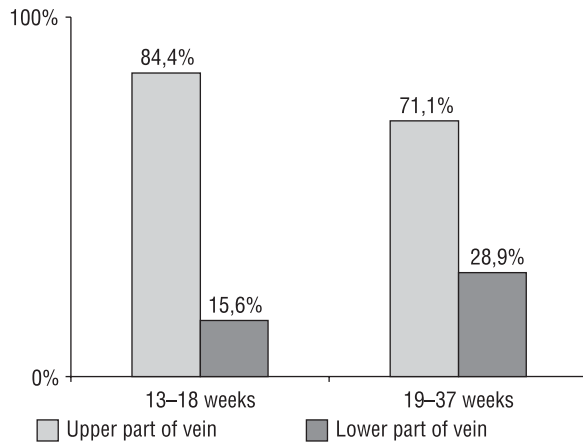


Figure 7. The distribution of valves in the right (R) and left (L) small saphenous veins.



**Figure 8.** The percentages of the distribution of valves in the small saphenous veins in 2 groups of fetuses.

Kampmeier and La Fleur Birch [8] described serially inspected sections of valves as developmental stages. They made 20 μm thick sections in which the reconstruction of valves is not precise.

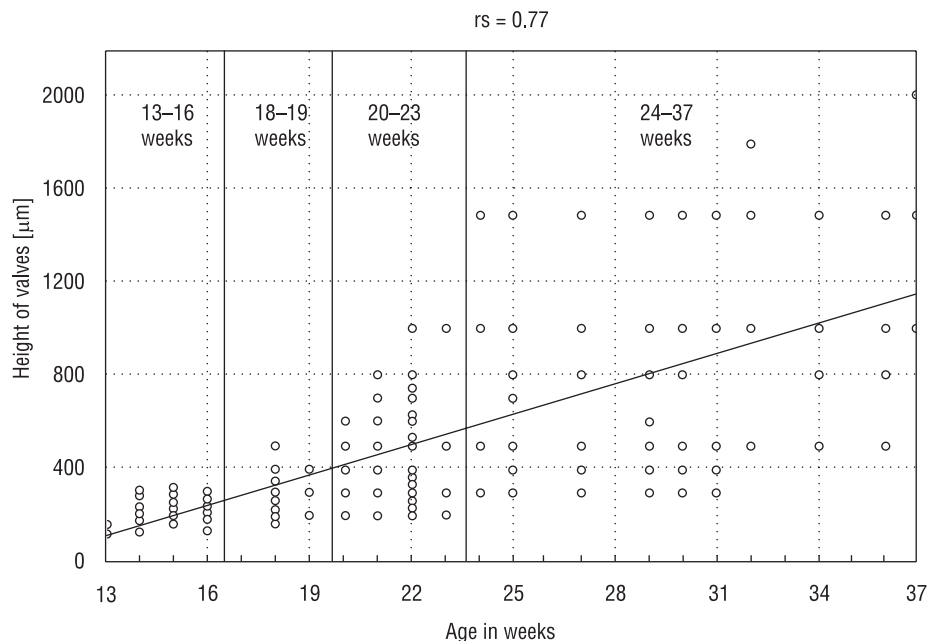
In the present and previously preformed studies [4, 5], the first valves were observed in the great saphenous vein in fetuses that were 13 weeks old. 1 or 2 valves were located near the termination of the small saphenous vein in the popliteal vein. According to Bochenek [1] the valves in superficial veins appear in the 3<sup>rd</sup> month while Kampmeier and La Fleur Birch [8] observed valves in a 3.5 month-old fetus.

In fetuses aged 13 to 18 weeks the number of valves increases from 1 to 8, whereas in fetuses between 19 and 37 weeks old, there is a stable count of 5 to 9 valves. This is in accord with Kampmeier and La Fleur Birch's [8] results. They found that the number of valves is stable from 5 months on. According to Glińska [6], the number of valves in small saphenous veins in fetuses between 4 and 9 months decreases.

Our study showed, that the height of the valves increases with the age of the fetuses, and that the height varies between fetuses of the same age as well as within the same vein. This gives evidence that the valves develop throughout the fetal period.

Zelikowski [15] and Bruska [2] observed valves near the orifices of the superficial veins. Marinov [11] noted the irregularity in the distribution of valves in the small saphenous vein. According to Glińska [6], the distance between valves in the small saphenous veins varies from 2 mm to 2.5 mm. Our study shows, that this distance varies from 0.5 mm to 18 mm and that the intervalvular distances were shorter in the upper parts of the veins.

Observations regarding the number of cusps in the small saphenous veins are not consistent. Certain authors believe that the valves are only bicuspid [9, 10, 13]. Others describe unicuspid and tricuspid valves [11]. In our study, only bicuspid valves were observed.



**Figure 9.** The height of valves in small saphenous veins in relation to the age of the fetuses.

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