

ACTA STEREOLOGICA 1983; 2: 388-394  
STEREOLOGY AND MORPHOMETRY IN PATHOLOGY  
Proc 2nd Symp Morphometry in Morphol Diagnosis  
Collan Y. et al., eds.  
Kuopio University Press, Kuopio 1983

## MORPHOMETRY OF NORMAL PLACENTAL TISSUE AT TERM

Ernst Joachim Noack, Wolfgang Wiest,  
and Roland Wurst

Frauenklinik, Klinikum Mannheim der Universität  
Heidelberg, D - 6800 Mannheim 1, West-Germany

### ABSTRACT

91 placentas of normal pregnancies at term after spontaneous deliveries were investigated by morphometry. The circumference, diameter and area of cross sections of placental villi and fetal capillaries, the percentage of epithelial plates of the circumference, and the degree of vascularisation was determined. Measurement was performed at the center and at the periphery of the placenta.

The diameter of the terminal villi was  $50 \mu\text{m}$  and the cross section area  $1977 \mu\text{m}^2$ . They were determined by eyepiece micrometer and optomanual planimetry, respectively. The degree of vascularisation was 33.0% by point count and 35.6% using optomanual planimetry. Percentage of epithelial plates of circumference was 8.7% when point count was used and 18.5% in case of planimetry.

### INTRODUCTION

Most of the changes in the human placenta in the progress of differentiation during pregnancy are of quantitative nature. The terminal villi become smaller while the fetal capillaries enlarge and form sinusoids. These changes are of interest to morphometry, as exactly measured data may help with a more accurate diagnosis. Concerning normal term placenta some data have been accumulated (Aherne and Dunnill 1966, Stieve 1935, Vogel 1975).

## MATERIAL AND METHODS

The data presented in this study were obtained from 91 placentas after uncomplicated pregnancies and spontaneous deliveries at term. After three weeks of fixation in four percent formaldehyde solution the placentas were cut into 12 to 20 one centimeter thick slices each. In addition to specimens taken for histological examination two blocks were cut from the center and from the periphery of the placenta and prepared for morphometric studies. We used HE- and HOPA- staining for point count and planimetry. In 56 placentas the terminal villi at the periphery of so called placentons (Schuhmann, 1976) were measured by planimetry of single villi with the MOP AM 01 by KONTRON, an optomanual planimeter. Using a method for point count described by Haug (1978) and Fritsch (1976) morphometric data from 35 placentas were obtained at the center and at the periphery of the placentons.

Schuhmann (1976) had found that at the center of placentons larger villi of a lesser degree of differentiation are found. Villi which do not show all criteria of full differentiation of normal term placentas given by Becker (1962) are not found at the periphery of placentons. Thus data of terminal villi obtained by morphometry of single villi by planimetry in this area will not be influenced by "younger" villi, like it would be, if measurements were done at the center. By planimetry the following data were measured: areas of cross sections of placental villi and fetal capillaries and the length of the epithelial plates using a method published in detail earlier (Noack et al., 1981).

By point count we evaluated the following data: the areas of cross sections of placental villi and fetal capillaries and the length of the circumference and the epithelial plates of villi. The diameter of terminal villi was determined by eye-piece micrometer. From these data we calculated the degree of vascularisation and the percentage of epithelial plates of the circumference of placental villi. By planimetry 50 villi per slide were measured. Point count pilot studies had shown that 50 fields of 100 squares at 250-fold magnification was sufficient. Doubling the number of fields did not improve accuracy. The data obtained by planimetry and by point count were compared with one another and results published in the literature.

## RESULTS

One of the most important criteria of differentiation of the placenta is the size of terminal villi. The mean area of

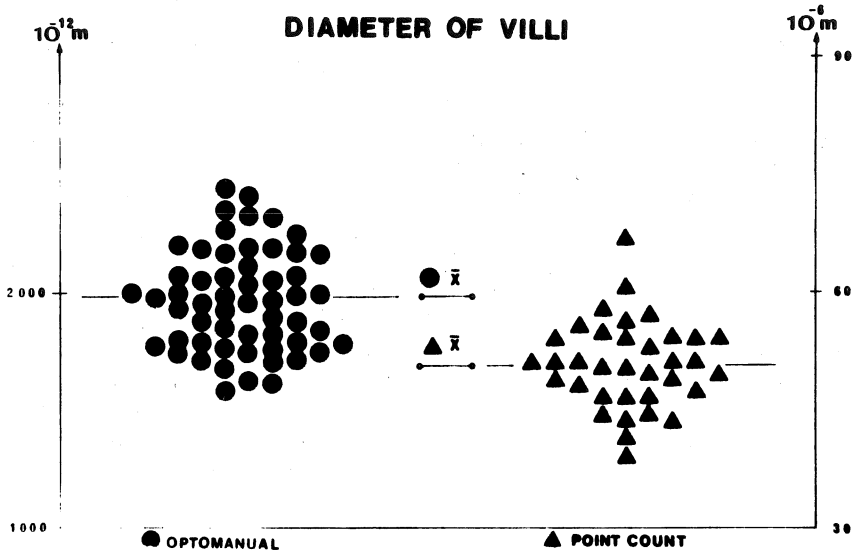


Fig.1. Areas of cross sectioned villi measured optomanually were  $1977 \mu\text{m}^2$  on an average. The mean diameter was  $50.1 \mu\text{m}$ .

cross section found by optomanual planimetry and the diameter by eye-piece micrometer were  $1977 \mu\text{m}^2$  or  $50.1 \mu\text{m}$ , respectively. Assuming that the cross section of a terminal villus is nearly circular the diameter can be estimated. The diameter of a circle covering an area of  $1977 \mu\text{m}^2$  is about  $60 \mu\text{m}$ . Because there is considerable standard deviation of more than 10%, the difference is not statistically significant.

As terminal villi form an important part of placental villi classification of villi and terminal villi was tried.

Table 1. Classification of placental villi.

The areas of cross sections and the diameter of terminal villi were attributed to 3 or 6 classes, respectively.

Class			Class		
1	$< 3000 \mu\text{m}^2$	87.3%	1	45 $\mu\text{m}$	43.1%
2	$3000-6000 \mu\text{m}^2$	11.4%	2	45-75 $\mu\text{m}$	34.0%
3	$> 6000 \mu\text{m}^2$	1.2%	3	46-120 $\mu\text{m}$	12.6%
			4	121-210 $\mu\text{m}$	5.7%
			5	210-300 $\mu\text{m}$	2.3%
			6	$>300 \mu\text{m}$	3.3%

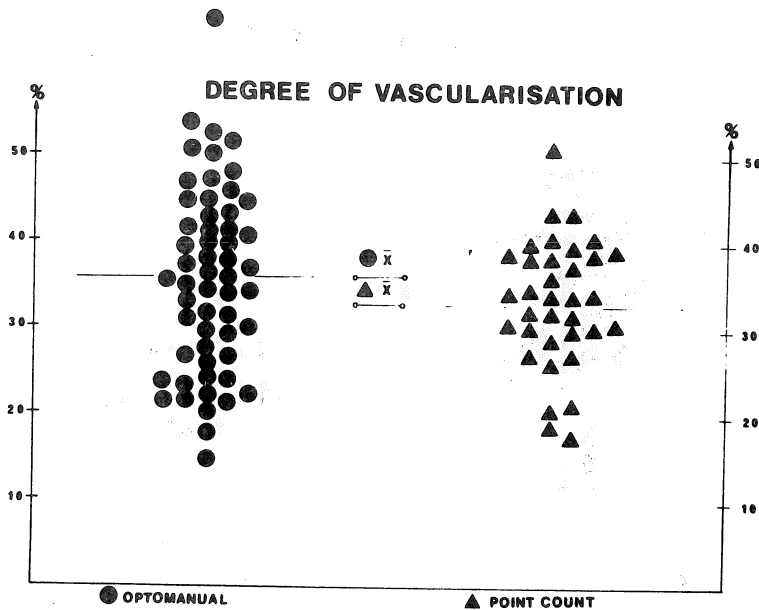


Fig. 2. The degree of vascularisation is 33.6% when measured with optomanual planimetry and 33.0% when measured with point count. Variation is considerable in both groups.

We chose 3 classes for areas and 6 for diameter. A detailed classification helped us to compare our results with those of other research groups. We formed classes of  $3000 \mu\text{m}^2$  for the areas and classes of 45, 30, 45 and  $90 \mu\text{m}$  for point count and eye-piece micrometer morphometry. 87.3% of all villi at the periphery of placentons were of less than  $3000 \mu\text{m}^2$ . 77.1% of all villi at the center and the periphery of placentons were less than  $75 \mu\text{m}$  in diameter.  $75 \mu\text{m}$  is the diameter of a circle covering  $4416 \mu\text{m}^2$  (Table 1).

From the areas of cross sections of terminal villi and fetal sinusoids we calculated the degree of vascularisation. Both methods yielded nearly the same results, optomanual planimetry at the periphery and point count at the center and the periphery of the placenta. We found a degree of vascularisation of 35.6% optomanually and 33.0% by point count. The variation of these data is great: we found 30% for optomanual planimetry and 25% for point count (Fig. 2).

Epithelial plates are the structures of the placenta in which the path for diffusion is shortest between maternal intervillous space and fetal sinusoids. Measured optomanually at the periphery of placentons we found a percentage of 18.5%

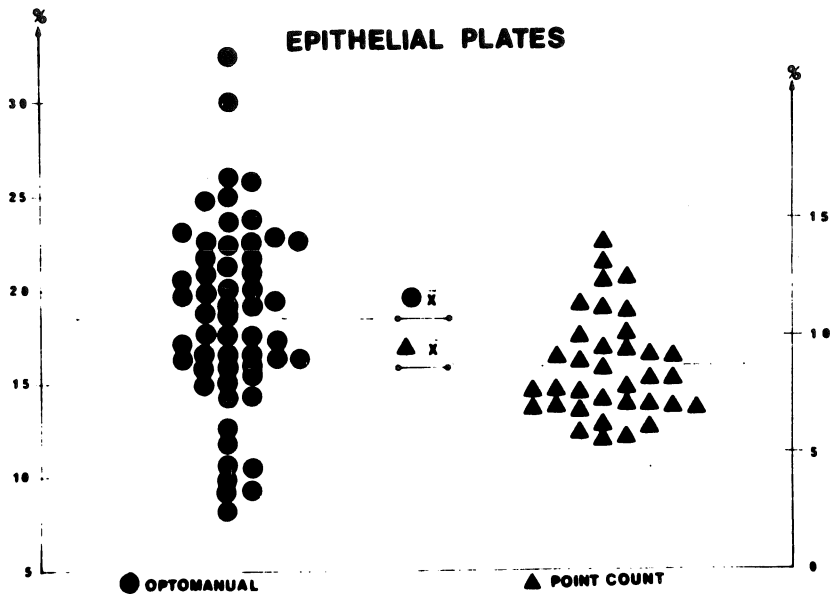


Fig. 3. Using both methods greatest differences were found in epithelial plates. Percentage of epithelial plates of circumference was doubled when optomanual planimetry was used.

of the circumference of the villi covered by epithelial plates. However, after point counting of the placenta it was only 8.76%. Standard deviation was about 25% in both methods (Fig. 3).

## DISCUSSION

It was the goal of this study to obtain morphometric data of normal placentas at term from the periphery and the center, both of the whole organ as well as its functional unit, the placenta. The results of optomanual planimetry and eye-piece micrometer measurements did not show any statistical difference. The eye-piece micrometer seems to be more exact because placental villi can be measured reliably in oblique sections also. The true diameter of terminal placenta villi is the smallest diameter of sections. Other authors found mean diameters of placental villi similar to our results: 40-70  $\mu\text{m}$  (Aherne and Dunnill 1966, Stieve 1935, Spanner 1941, Strauss 1964). Like Vogel (1975), and Estel et al. (1973) we found a great variation in the degree of vascularisation. The standard deviation of the means of both our methods was about 30%. Optomanually we measured SD of 36.6%, by point count 33.0%. Schrodt (1970) reported 15% and Estel et al. (1973) 66%.

Epithelial plates were measured significantly larger using optomanual planimetry at the periphery of the placentons than using point count at the center and the periphery of the placenton. One of the possible reasons may be that epithelial plates are better developed at the periphery of placentons. On the other hand a systemic fault of planimetry is thinkable: the borders of epithelial plates are not always well defined and may be measured larger by a method that outlines this structure than by point counting. Other authors report data between 20-58% (Vogel, 1975, Schweikhart and Kaufmann, 1977).

#### REFERENCES

- Aherne, W., Dunnill, M.S.: Morphometry of human placenta. Brit. Med. Bull. 1966; 22: 5-8
- Becker, V.: Funktionelle Morphologie der Placenta. Arch. Gyn. 1962; 198: 3-28
- Estel, C.H., Gerl, D., Kadner, J., Kreuziger, K.P.: Verhältnis von fetaler Gefäß- und Zottenoberfläche in der menschlichen Placenta. Zbl. Gynäk. 1973; 95: 113-116
- Fritsch, R.S.: Grundlagen der stereologischen Volumen- und Oberflächenanalyse. Gegenbaurs morph. Jahrb. Leipzig 1976; 122: 325
- Haug, H.: Die verschiedenen Verfahren zur Werterfassung in der biologischen Morphometrie und Stereologie. Microscopica Acta 1978; 78: 259-262
- Noack, E.J., Stoz, F., Schuhmann, R.A.: Morphometrische Untersuchungen an Plazentazotten reifer menschlicher Plazenta. Z. Geburtsh. u. Perinat. 1981; 185: 155-160
- Schrodt, U.: Morphometrische Untersuchungen der Placenta bei dystrophen Neugeborenen. Zbl. Gynäk. 1970; 92: 671-673
- Schuhmann, R.: Die funktionelle Morphologie der Placentone reifer menschlicher Placenten. Organisation Gestosis Press (1976)
- Schweikhart, G.P., Kaufmann, P.: Zur Abgrenzung artefizieller und pathologischer Strukturen in reifen menschlichen Placentazottern. Arch. Gynäk. 1977; 222: 213-230
- Stieve, H.: Neue Beobachtungen über den Bau der menschlichen Placenta. Zbl. Gynäk. 1935; 59: 434-446

Strauss, F.: Bau und Funktion der menschlichen Placenta.  
Fortschr. Geburtsh. Gynäk. 1964; 17: 3-29

Vogel, M.: Placentagrösse und -struktur als Voraussetzung für  
den Wachstumsstand des reif geborenen Kindes bei der Geburt  
mit besonderer Berücksichtigung der Placentastörungen.  
Habilitationsschrift, Berlin (1975).