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MORPHOLOGICAL STUDIES ON THE PLACENTA

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INDEXING WORDS

chorionic villi; immunohistoenzymatical studies; syncytial knot

SYNOPSIS

Morphological studies were done on 109 placentae of 6 to 43 gestational weeks. Soft x-ray figures are useful for detecting the development of the placenta, which is closely correlated to enlargement of cotyledon and vascular growth in the chorionic villi. At histological figures, chorionic villi, corresponding to intermediate mature villi at the early gestational weeks, reveal large size with edematous stroma and prominent interstitial cells. Their size becomes smaller with aging, with decreased interstitial cells and stroma. At the early gestational period until 23 weeks, chorionic villi are lined by two cell layers of S-(syncytial) and C-(cytotrophoblastic) cells. After 24 gestational weeks C-inner lining decreases in number. Syncytial knots become marked after 32 weeks. As aging, the intervillous space becomes narrow and is occupied by the small sized terminal and mature chorionic villi with congestive capillaries. Syncytial knots and fibrin deposit around chorionic villi are increased with placental aging. By the immunohistoenzymatical examination, S-lining is positive by hCG (human Chorionic Gonadotropin) at the early gestation, but is markedly positive by hPL(human Placental Lactogen) and SP-1(Specific Protein 1) lately.

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INTRODUCTION

The placenta is the most important accessory fetal structure, partly of maternal and partly of fetal origin. Clinical placental examination is mainly based on laboratory data such as hCG or hPL and on ultrasonographic examination .[5,6] Compensatory and reserve potentialities of the placenta are important but difficult to estimate from these clinical examinations.

In the field of pathology, the placenta is one of the largest organ that is served as a specimen. We can approximate where the etiology of the illness existed or how the maternal or foetal condition was, even when autopsy of neonates or stillborns are not done. If we do not examine macroscopic findings and histological cutting of the placenta for themselves, we can not get a correct diagnosis. Fundamental criteria on development of the placenta are useful to estimate correct or distorted functioning .

MATERIALS AND METHODS

One hundred and nine placentae whose gestational age were between 6 and 43 weeks were studied(Table 1). In all 109 cases there were not any complications of cardiovascular and endocrine systems, autoimmune or renal diseases, or toxicosis of respective mothers, which might cause abnormal development of the placenta. The one hundred and nine neonates delivered from these mothers were healthy without any abnormalities. Furthermore, all placentae were examined after permission was given by their families. The placentae of early pregnancies between 6 to 24 gestational weeks were obtained from artificial abortion because of reasons other than maternal medical complications. None of the cases of the premature delivery had significant clinical symptoms other than premature labor. Their histological figures revealed neither chorio-amnionitis nor villitis, and embryonal development was approximately same as those of the corresponding age. Eighty six placentae were injected 50% BaSO4 solution from umbilical vein and were photographed by soft x-rays (Softex CMB-2, Softex Co. Ltd.). Those placentae were fixed in 10% formalin solution, from which 8 blocks about 2 x 3 x 0.5 cm in size were made. They were processed routinely in paraffin embedding, then cut at 4 micra thick serial sections. Histological sections were stained with

HE(Hematoxylin Eosin), EV(Elastica VanGieson), PAS(Periodic Acid-Schiff), PTAH (Phosphotungustic Acid Hematoxylin) and Azan stains respectively. Immunohistoenzymatical stains for hCG, hPL and SP-1 used by PAP (peroxidase anti-peroxidase) methods were examined(Figure 1). Histological evaluation was done from the characteristics to be found positive more than 80% in histological sections. Syncytial knots examined histometrically in each section at a certain unit area, and calculated mean ± SD in respective cases.

Table 1. Examined placentae

GW	Softex(-)	Softex(+)	Total
6-11 weeks	18	0	18
12-23	5	4	9
24-31	0	10	10
32-36	0	19	19
37-41	0	49	49
42-43	0	4	4
Total	23	86	109

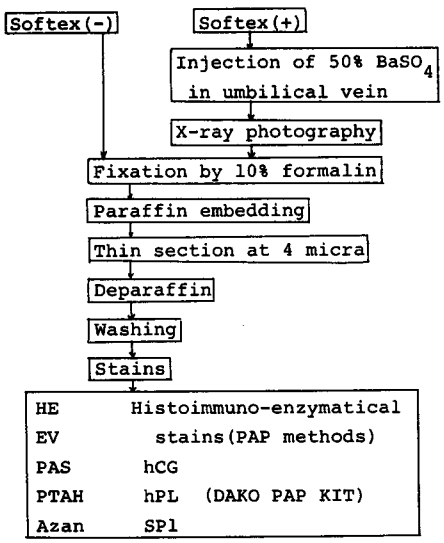

Fig. 1 Methods

RESULTS

Histological observation on the placentae was focused to the peripheral villi less than 100μm in diameter. Morphological characteristics were written in accordance to respective gestational weeks of examined placentae as shown in Table 2.

a. 6~11 gestational weeks

Macroscopic observation or soft x-ray examination is not done in the placentae in 6 to 11 gestational weeks, since they are obtained in pieces at artificial abortion. Histologically, the placenta contained stem villi and a few mesenchymal villi communicating to the stem villi. There were only a few mature intermediate villi at peripheral ramification. They were round or slender in shape and various sized(Figure 2a). They were compactly and thickly lined by S- and C-cells. The stroma was edematous and contained a few capillary vessels in the central area, which had narrow lumina without identifiable media or adventitia(Figure 2b). Thick basement membrane was identified between S- and C-cells. S-cells revealed rich cilia in their surface. Syncytial knots were not found in any sections, which were characterized by accumulation and budding of S-cells. Immuno-histoenzymatical stains revealed strongly positive in S-cells by hCG, but faintly positive in them by SP-1 and hPL(Figure 2c, d).

b. 12~23 gestational weeks

The macroscopic figures of the placenta was flat and small in cotylendons' size. The x-ray figures revealed small lobes(Figure 3a), composed of 10.1± 6.2 cotyledons in number. Histologically there were stem villi with more than fifth to tenth order, immature and mature intermediate villi, a few mesenchymal villi. The mature intermediate villi were slender or oval in size with broad intervillous space(Figure 3b). There are also capillary vessles in the center of the villi without contact to intervillous space(Figure 3c, d). The S- and C-cells' lining was preserved at the villous surface, but total number of C-cells was decreasing markedly. Microvilli of S-cells became obscure at this period. The syncytial knots were positive only in 1.2± 0.3% of peripheral villi. The decidual arteries in the center of the cotyledon revealed thick media and adventitia. The hCG stain became faintly positive or negative, but hPL became positive as aging. The decidual arteries showed thick media and narrow lumina.

Table 2. Change in placental aging

Gestation			6 -11 weeks	12 -23 weeks	24 - 31 weeks	32 - 36 weeks	37 - 41 weeks	42 - 43 weeks
Macroscopic characteristics				flat and massive	coasely lobulated	lobulated	Cauliflower like, lobulated	Cauliflower like, lobulated
Nrs. of cytoledons				12.1±6.2	20.0±4.2	35.1±5.5	50.1±5.2	56.2±6.0
MICROSCOPIC	PCV	Chracteristics	two layers: inner; C-cells outer; S-cells with rich cilia	S-cells, decreased C-cells, broad intra-villous space	single layer S-cells, columnar, moderaty wide villous space	thin S-cells, narrow intra-villous space	thin S-cells, narrow intra-villous sapce	fibrin(+) calicification(+) narrow intra-villous space
		hCG, hPL and SP-1 in S-cells	hCG					hPL,SP1
		SK %		1.2±0.3	2.3±0.2	5.0±0.4	10.5±3.4	22.0±5.4
		Capillaries	poorly deve-loped, centrally	developing, centrally	developed peripherally	congestive, VSM(+)	congestive, VSM(++)	congestive, VSM(+)
		Interstitium	edematous HC(++)	HC(+)	HC(+~-)	HC(+~-)	HC(+~-)	HC(+~-)
	Decidual artery			narrow lumina thick-media	atherosis(+)	widened lumina, atherosis(++)	widened, atherosis(++)	widened lumina, atherosis(++)

Nrs: numbers, PCV: peripheral chorionic villi, SK: syncytial knots, VSM: vasculosyncytial membrane

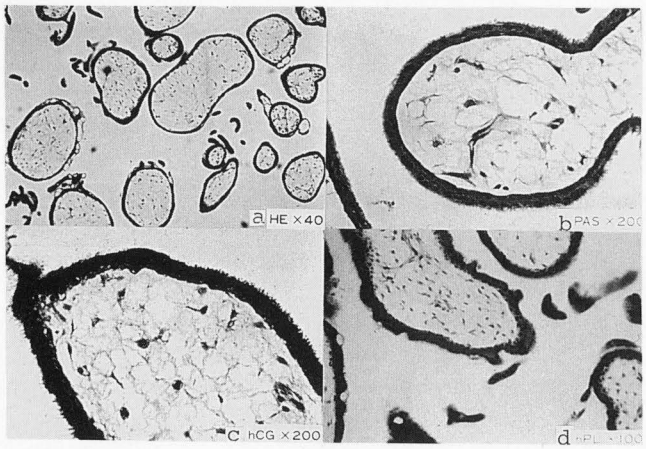

Fig. 2: Gestation 6-11 weeks

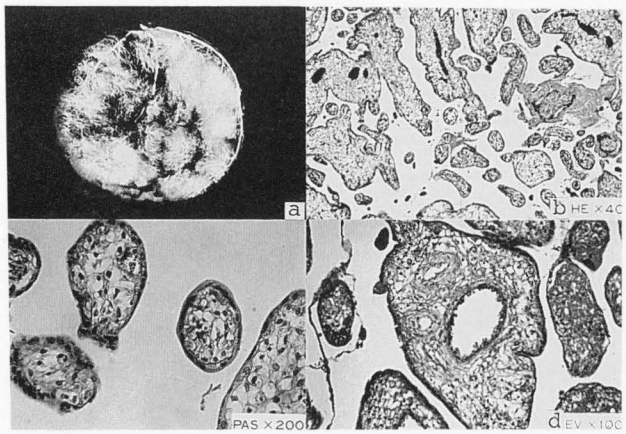

Fig. 3: Gestation 12-23 weeks

c. 24~31 gestational weeks

The placenta showed coasely lobulated cotyledons(Figure 4a) composed of 20.0± 4.2 in average. Histologically, there are many mature villi(terminal villi), in which capillaries located to the periphery of the villi but only a few capillaries are exposed to the intervillous space. The mature villi were lined mostly by a single layered S-cells (Figure 4b). They were round and cuboidal in shape, and thick. Their cytoplasms were positively stained by hPL and SP-1 but negative by hCG(Figure 4c). The interstitial stroma was slightly fibrotic(Figure 4d). Syncytial knots were 2.3± 0.2% in unit area of chorionic villi. Decidual arteries showed slight atherosis and their lumina became large.

d. 32~36 gestational weeks

The placenta showed lobutation and the average number of cotyledons 35.1± 5.5. They were clearly delineated each other without respective close communications(Figure 5a). The intra-villous space was narrow(Figure 5b). Thin S-cells lined by a single layer and formed vasculosyncytial membrane(Figure 5c). S-cells were positively stained by hPL and SP-1, but negative by hCG. The syncytial knots were 5.0± 0.4% in unit area of chorionic villi with fibrin deposit(Figure 5d). The decidual arteries showed marked atherosis and their lumina were widened.

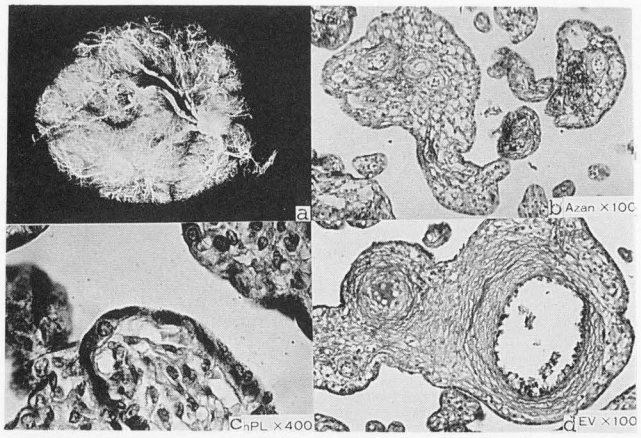

Fig. 4: Gestation 24-31 weeks

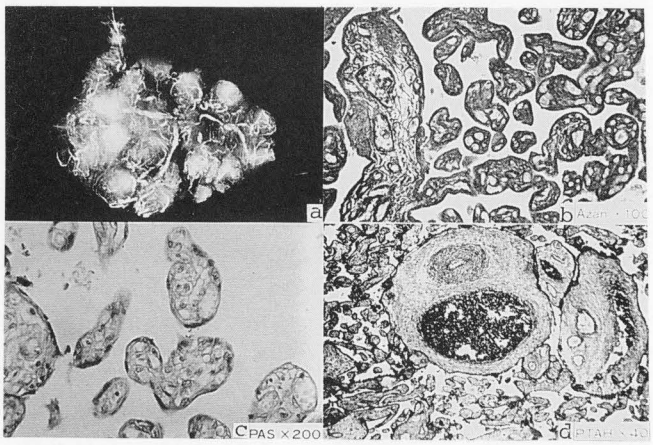

Fig. 5: Gestation 32-36 weeks

e. 37~41 gestational weeks

The placentae were lobulated just like cauliflower like appearance, which were communicated each other(Figure 6a). The average number of cotyledons were 50.1± 5.2. Thin S-cells and capillary vessels formed vasculosyncytial membrane(Figure 6b). Capillary vessels were proliferated and enlarged in their lumina by congestion. S-cells were negative by hCG stain(Figure 6c), but positive by hPL and SP-1(Figure 6d). Increased syncytial knots counted as the titer of 10.5±3.4%. Decidual arteries showed marked atherosis and widened.

f. 42~43 gestational weeks

The placentae were congestive and larger and had 56.2± 6.0 cotyledons. Their soft x-ray's appearance was cauliflower like and lobulated with respective close communication(Figure 7a). The chorionic villi showed increased number of syncytial knots, 22.0± 5.4%, with fibrin and calcium deposits (Figure 7b). There were occasionally microscopic infarctions (Figure 7c). S-cells were negative by hCG, but positive by SP-1 and hPL(Figure 7d). The wall of decidual arteries showed marked atherosis and degenerative tendencies.

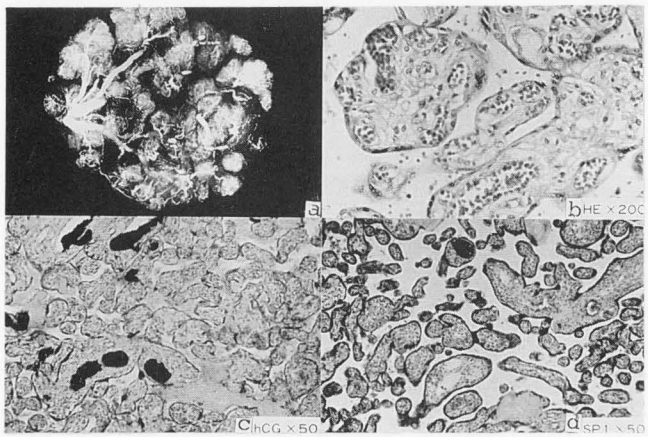

Fig. 6: Gestation 37-41 weeks

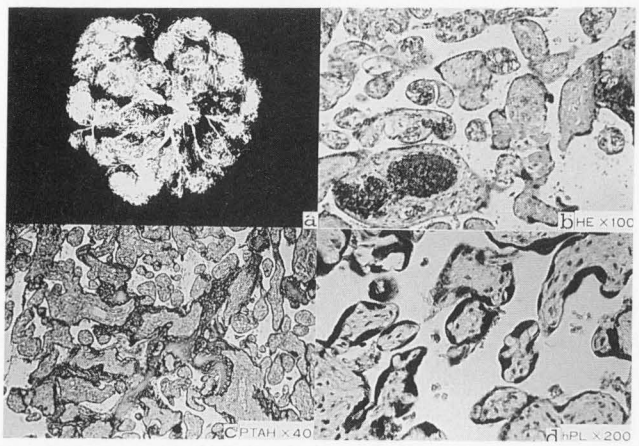

Fig. 7: Gestation 42-43 weeks

DISCUSSION

Development of imaging diagnostics such as Doppler sonography has made it possible to examine placenta morphologically in utero. Grannum P.A.T. et al[5] classified the grade from 0 to 3 of the placental maturity changes by multiple ultrasound evaluation, and suggested the correlation between the maturational grade of the placenta and fetal pulmonic maturity. Jauniaux E.[6] examined gestational age and placental thickness, circumference, and volume in uncomplicated pregnancies, and concluded the doppler analysis may allow more efficient screening for the examination of abnormal placental examination. However, vasculosyncytial membrane involving capillary growth in chorionic villi and the gas exchange ratio between maternal and foetal circulation in the development of the placenta, are not well understood even by doppler sonography and other medical apparatus.[3,10]

This study was done morphologically on the development of the placenta. C-cells decrease in their number from 16 gestational weeks as reported by many researchers. Ruckhaeberle K. E. et al.[7] describe C-cells' disapperance to be maturation arrest or degenerative. Its meaning is still unknown, however, it is described also that a higher oxygen concentration at the peripheral villi is useful for the active proliferation of S-cells, but lower oxygen supply causes a decrease in C-cells, just beneath the surface S-cell layer. Transformation to S-cells from C-cells when the concentration of the oxygen decreases during the development of the placenta.

Syncytial knots are most typically found increasing from 34 gestational weeks. Full term placentae have many syncytial knots with fibrin deposit and calcification. Though the role of the syncytial knots are disputed to date, densely packed nuclei are pycnotic, cytoplasms degenerative.[8] These structure may cause the thining of the basement membrane of capillary vessels and as these results exchange of metabolite or oxygen via basement membrane becomes increased. Calcification in the syncytial knots may be a result of degeneration of circulatory disturbance.

Another important problem is spiral artery located at the center of the cotyledon, some of which are correspond to decidual arteries. At 12~23 gestational weeks the decidual arteries show narrow lumina and thick media, afterthen they show trophoblastic invasion in the wall and widening of their lumina. Brosens[2] pointed out l977 intimal structural changes of

spiral arteries, characterized by atherosis, to be closely stenotic are more important to clarify the mechanism of the development of the placenta. More specifically trophoblastic invasion and subsequent atherosis cause destruction of the elastic laminae and induce relaxation of placental blood pressure.[1,4,9] These arteries may regulate the blood supply of maternal placentae and necessary for the maintenance of blood pressure and for the prevention from meternal renal disorder or toxemia.

In our examination using hCG, hPL and SP-1, in the placental histology showed characteristic curves: an earlier elevation of hCG and gradual elevation of hPL and SP-1. The higher positive of hCG in S-cells in the earlier gestation serves to protect that fertilized ovum against maternal abortion. The hCG plays an important role in the preservation of the pregnancy, specifically keeping the high hCG level of maternal blood serum at earlier stage of pregnancy. After 16 gestational weeks hCG level falls significantly,when the placenta is formed sufficiently . On the other hand, hPL positivity is low at earlier stage of the placenta, and then it gradually rises and becomes significantly higher at full term. The higher level of hPL is correlated to the development and growth of fetal organs and induce maternal lactation at delivery. The hPL in the placenta is stained strongly positive in S-cells. This increasing level of hPL may be proportionate to the increased S-cells in the increasing size of the placenta.

These fundamental studies on the placenta are helpful in evaluating placental function, and in the clarification of the pathogenesis of neonatal and premature diseases, as well as that of stillborn .

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