THE AVERAGE AREAS OF GLOMERULAR PROFILES IN DIFFERENT CORTICAL ZONES DURING HUMAN FETAL KIDNEY DEVELOPMENT

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Introduction and objectives:

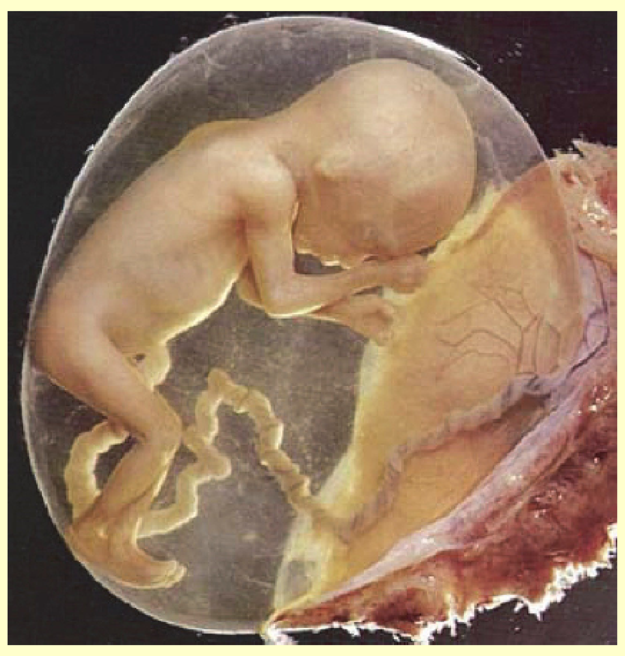
Development of the permanent human kidney, metanephros, occur in the 5^{th} week of gestation as the result of reciprocal inductive interactions between ureteric bud and metanephric blastema. Glomeruli are formed at about 8^{th} week of gestation, and shortly after that become functional. Glomerulogenesis is complete at 36^{th} week of gestation and every kidney contains definitive number of glomeruli. The initial process through which primitive glomeruli attain specific anatomic form, together with increase of renal function, is the process of maturation.

Our aim was to study the average tuft areas of the glomerular profiles in different cortical zones of the normal fetal kidney in different gestational ages.

Methods:

Thirty human fetal kidneys of single pregnancies were studied. The foetuses were obtained from spontaneous abortions caused by prematurity or prenatal asphyxia, from the Institute of Pathology, Clinical Centre Nis, Serbia. The last menstrual period and crown-rump length of the foetuses were used to determine the gestational age which ranged from 4^{th} lunar month to 10^{th} lunar month. In order to record a generation of new glomeruli correctly, we divided 4^{th}, 5^{th} and 6^{th} lunar month into the first (a) and second half (b). This kind of division allows us to compare one group to another. The kidney tissue fragments were prepared by classic histological method, and stained with haematoxylin-eosin. The tuft area of the glomerular profiles was measured using standard stereological point-counting method and an M_{42} multipurpose test-system. We analysed approximately 20 to 25 microscopic fields per kidney.

Table 1. Distribution of fetuses by gestational age, sex and crown-rump length.



Lunar month	Agr (weeks)	Sex: Female	Sex: Male	Crown-rump length (mm)
4^{th}_{a}	12.1-14	1	2	96.40±6.07
4^{th}_{b}	14.1-16	1	2	130.80±8.70
5^{th}_{a}	16.1-18	1	2	154.00±5.48
5^{th}_{b}	18.1-20	2	1	176.00±8.94
6^{th}_{a}	20.1-22	1	2	202.00±4.47
6^{th}_{b}	22.1-24	2	1	222.00±5.70
7^{th}	24.1-28	3	-	243.00±9.75
8^{th}	28.1-32	1	2	268.00±13.87
9^{th}	32.1-36	2	1	318.00±13.04
10^{th}	36.1-40	2	1	361.00±2.24

Results:

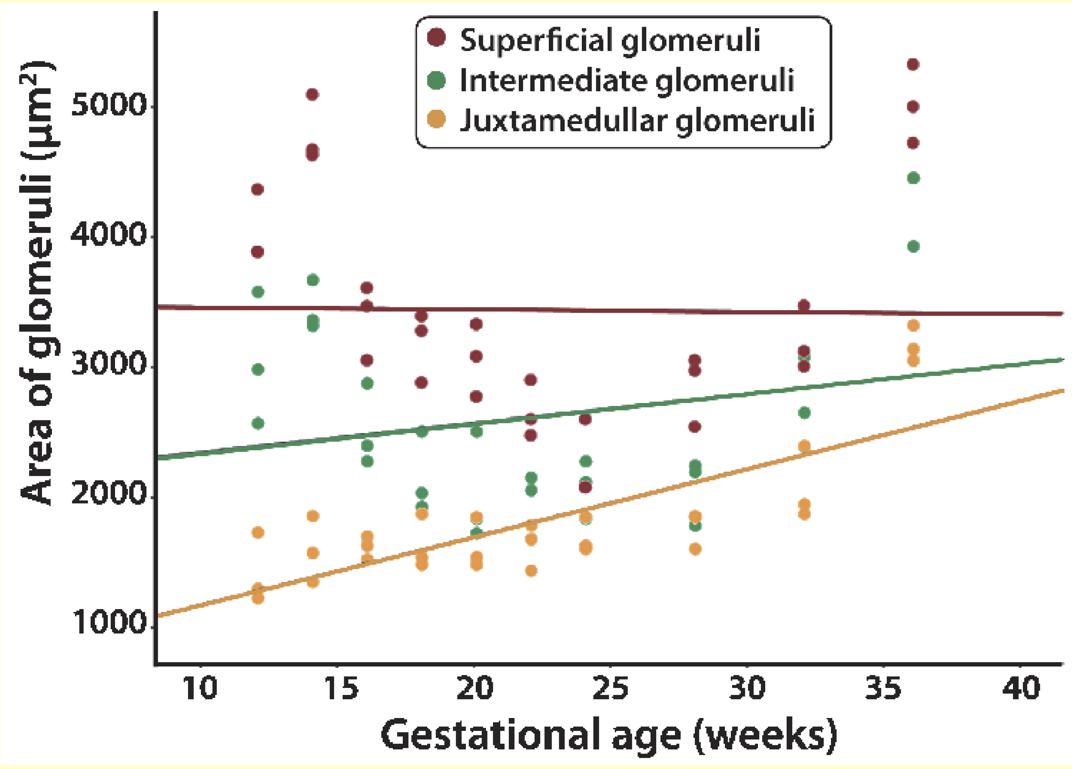
Glomeruli in the superficial cortical zone showed the lowest average tuft area. The values showed constant increase from first half of the 4^{th} lunar month (1458.52 ± 273.62 μm^2) until 10^{th} lunar month (3213 ± 183.57 μm^2). The glomerular tuft area in the intermediate cortical zone increased from 3044.05 ± 597.56 μm^2 to 4275.72 ± 302.56 μm^2, during the same gestational period. The glomerular tuft area of the largest juxtamedullar glomeruli increased from 4056.69 ± 275.55 μm^2 to 5026.67 ± 301.90 μm^2. The average glomerular tuft areas increased statistically significant in all renal cortex zones during the 10^{th} lunar month ($p < 0.05$).

Table 2. Average tuft areas of the glomerular profiles in fetal kidney cortical zone (μm^2)

Lunar month	Superficial zone X±SD	Superficial zone 95% CI	Intermediate zone X±SD	Intermediate zone 95% CI	Juxtamedullary zone X±SD	Juxtamedullary zone 95% CI
4^{th}_{a}	1458.52±273.62	778.81-2138.16	3044.05±597.56	1783.19-4304.91	4056.69±275.55	3372.19-4741.19
4^{th}_{b}	1633.63±251.62	1008.56-2258.70	3451.67±190.76	2977.81-3925.53	4808.67±256.63*	4171.17-5446.17
5^{th}_{a}	1658.80±87.58	1441.24-1876.36	2517.32±317.01	1729.84-3304.80	3387.20±289.77**	2667.38-4107.02
5^{th}_{b}	1673.46±210.27	1151.12-2195.80	2155.78±307.66	1391.51-2920.05	3194.64±268.84	2526.80-3862.48
6^{th}_{a}	1664.99±196.26	1177.44-2152.54	1951.71±304.01	1196.51-2706.91	3072.71±278.97	2379.70-3765.72
6^{th}_{b}	1675.18±178.19	1232.53-2117.83	1962.71±247.84	1347.05-2308.37	2668.75±218.43	2126.14-3211.36
7^{th}	1734.88±134.19	1401.52-2068.24	2076.79±224.04	1520.23-2633.35	2262.00±301.38	1513.34-3010.66
8^{th}	1810.80±143.58	1454.12-2167.48	2074.00±254.32	1442.23-2705.77	2865.75±274.62	2183.57-3547.93
9^{th}	2054.86±183.23	1599.70-2510.02	2704.93±348.48	1839.25-3570.61	3029.33±241.47	2429.48-3629.18
10^{th}	3213.01±185.57**	2870.14-3555.88	4275.72±302.56**	3528.12-5031.32	5026.67±301.90**	4276.72-5776.62

X - mean value; SD - standard deviation; CI - confidence interval
* - $p<0.05$, ** - $p<0.01$ - Statistically significant difference compared to previous age group

Correlation between the gestational age and area of glomerular profiles in superficial, intermediate and juxtamedullar zone of the fetal kidney cortex



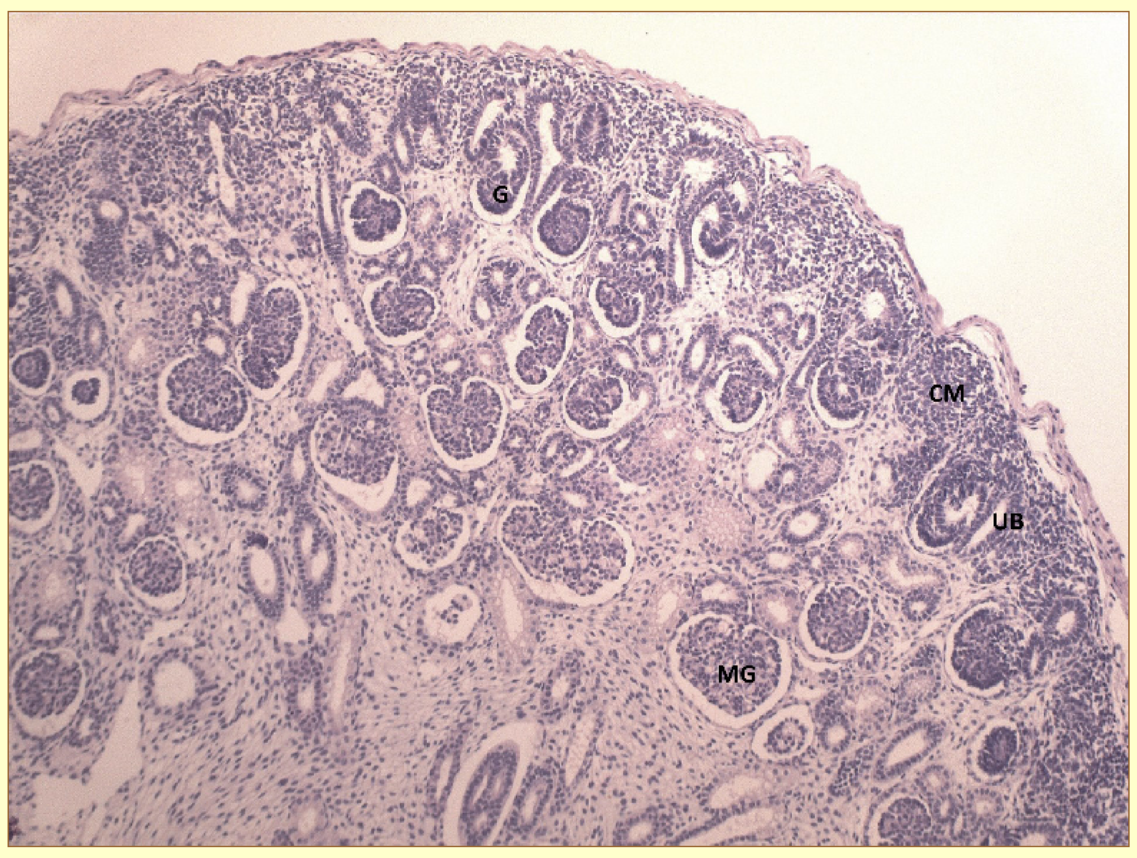


Figure 1. Human fetal kidney at 14^{th} week of gestation. The thin cortex contains a nephrogenic zone with condensed mesenchyme (CM), terminal end of the ureteric bud (UB) and the vesicle at the earliest stage of nephron development. Small vascularized glomeruli (G) are located in the superfitial parts of the cortex. The nephrons with the mature glomeruli (MG) and proximal and distal tubules are located deeply. (HE, X200)

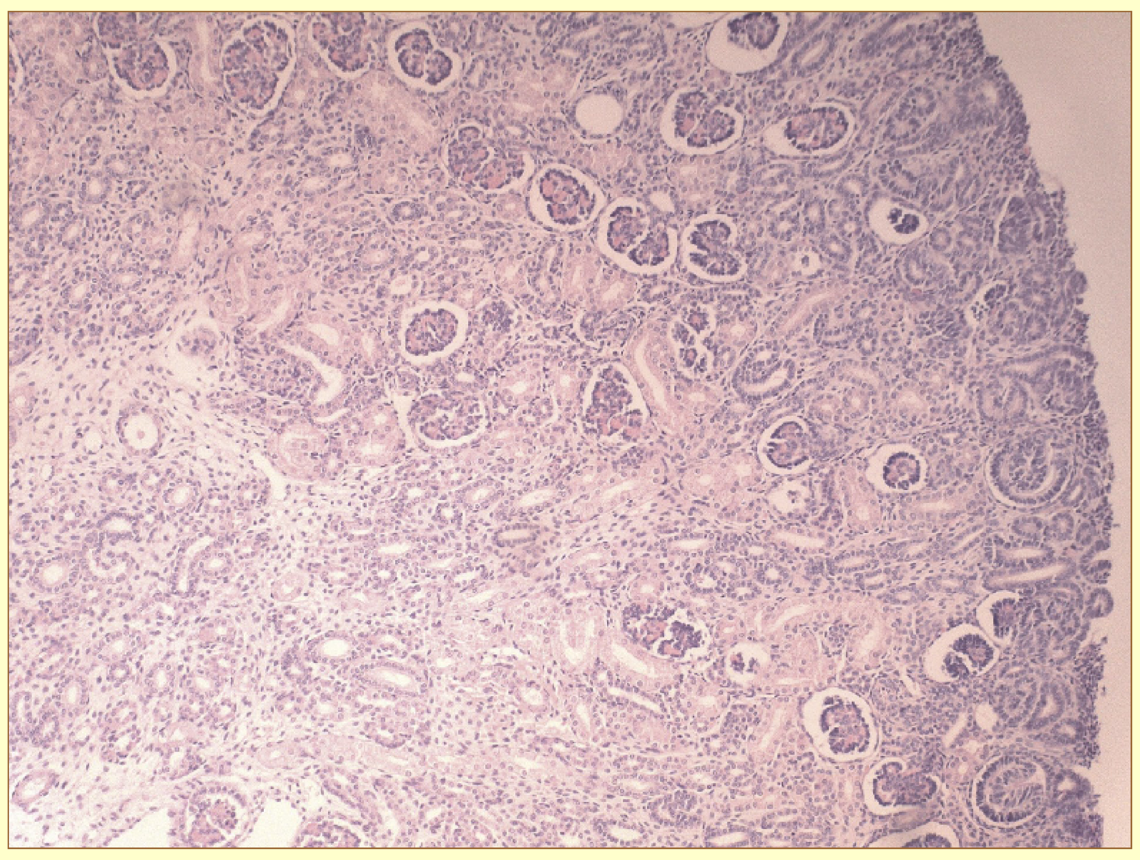


Figure 2. Part of the kidney cortex in the 24^{th} week of gestation. The nephrogenic zone becomes thinner. (HEX200)

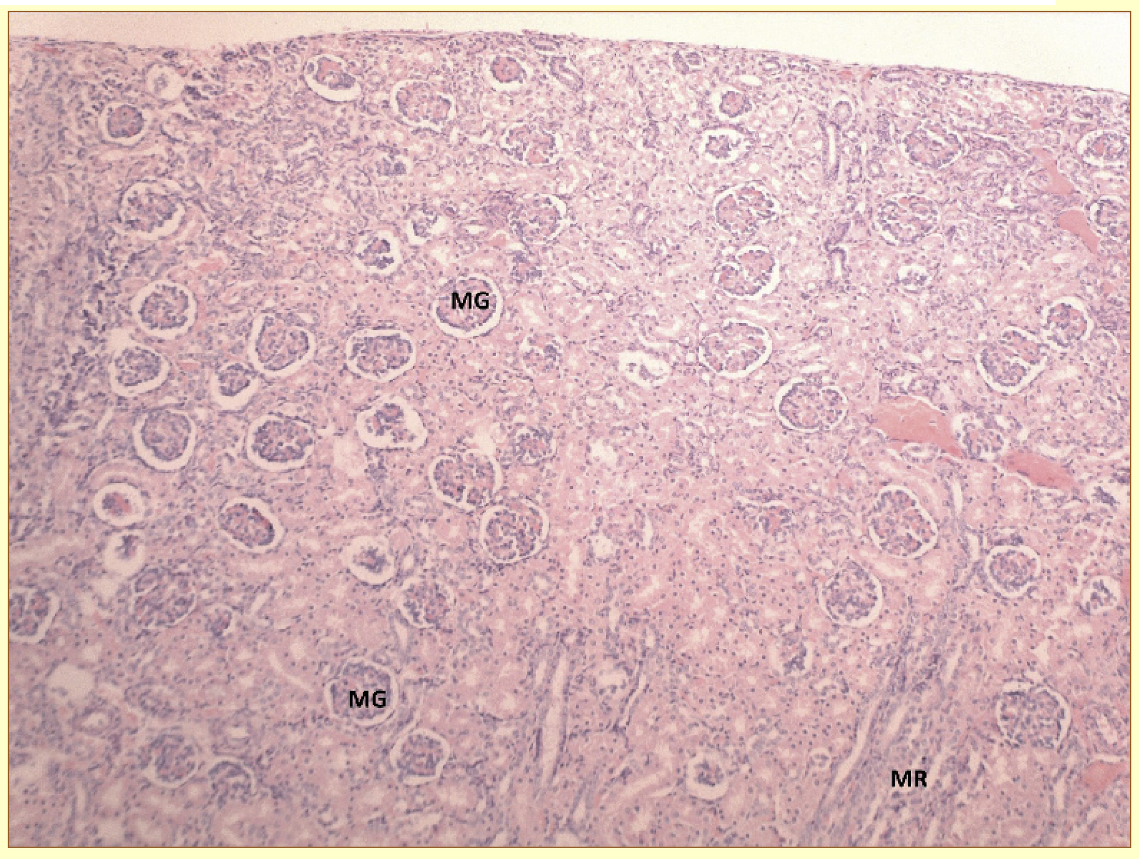


Figure 3. Cortex of the human kidney in the 40^{th} week of gestation. Mature glomeruli are organized in columns between which there are the medullary rays (MR). (HE, X100)

Conclusions:

The average glomerular profile area increased during intrauterine growth in all cortical zones of the metanephros. Our results indicate that the size of glomeruli in different periods of fetal growth can be primary parameter to follow renal growth, and predict its function.

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