e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(5); 222-226

Original Research Article

Morphological Analysis of Fetal Dissection of Human Kidney

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Received: 16-02-2024 / Revised: 07-03-2024 / Accepted: 10-04-2024
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Conflict of interest: Nil

Abstract

Background and Objectives: Adipose tissue surrounds a pair of bean-shaped kidneys that are located posteriorly below the peritoneum, one on either side of the spinal column. The average kidney is 11 cm long, 6 cm wide, and 3 cm thick anteroposteriorly. Lower poles of the kidney are associated with the third lumbar vertebra, whereas upper poles are located at the level of the12th thoracic vertebra. Because of its proximity to the right lobe of the liver, the right kidney is slightly lower than the left. The left kidney is located closer to the median plane than the right kidney and is a tiny bit longer and narrower. Theanterior and posterior aspects that are typically characterized are, in fact, anterolateral and posteromedial because the longaxis of each kidney is pointed inferolaterally and the transverse axis posteromedially. Morphological and stereological parameters of developmental anatomy of kidneys are directly related to manifestations of renal disorders. In the present study, the morphological data denoting the various embryonic developmental stages of human fetal kidney were collected and tried to establish the correlation of the same with the gestational age of the fetus and further the histogenesis of the human fetal kidney was also studied in the Indian population. Fetal dissection of human kidney morphological analysis. This study provides autopsy standards for body weight, bodydimensions, and fresh organ weights for non-macerated fetuses.

Material and Method: This study was carried out in the Department of Surgery in NMCH, Patna. The abortus/fetus used in this study weregathered from the Department of Surgery and Obstetrics and Gynecology. 40 fetuses between the ages of 14 and 40 weeks were gathered. For the benefit of the parents and close relatives, the consent form was written in both Hindi and English. Once we receive information from sister-in-charge of labor room about availability of fetus, we immediately rushed to the labor room.

Conclusion: It was concluded that in the present study that fetal weight in the population is lower than the same from Nepal as well as Eastern India. Up to second trimester end, the Gujarati fetuses were found to be heavier than the American fetuses. At terms, the Dennis, the Australian and the Gujarati fetuses were comparable in weight. In the last trimester, fetuses of Gujarati population weigh lighter than the same from the French.

Keywords: Fetal weight, Gestational week, Crown-rump Length, Crown-heel length Occipito-frontal diameter.

Introduction

Metabolic waste products and also the extra amount of water is excreted through the kidney. [1] Functions of thekidney are vital for the upkeep of water and electrolyte balance as well as controlling the concentration of various substances in the human body. [2] The bean-shaped kidneys are located on either side of the spinal column in the upper part of the abdominal cavity. The adipose tissue that serves as a cushion surrounds the kidneys. The kidneys are held in place by a membrane made of fibrous connective tissue andadipose tissue called the renal fascia. [3] Because of largersize of right lobe of liver right kidney lies at a rather lower level than the left kidney. Each kidney moves around 2.5 cm up and down in an extremely vertical orientation in response to the diaphragm's breathing movements. In a person with poorly developed abdominal muscles at the endof deep inspiration, lower pole of right kidney can be palpated in the right lumbar region, while the normal left kidney is situated at a higher level than the right kidney andis not palpable. [4] The pelvic area is where both kidneys grow in the early embryo. Later, they change their abdominal position to one that is more cranial. The decrease in the body's curvature and the expansion of the lumbar and sacral areas of thebody are both responsible for the kidney's ascent. At almost12 weeks of gestation, the definitive kidneys start to work. The placenta performs the job of the kidneys during fetal life, which means that the kidneys are not in charge

of waste product excretion. Urine enters the amniotic cavity throughout fetal life and combines with the amniotic fluid. The fetus inhales the fluid, which the kidneys then recycle. [5] Morphological formation of human fetal kidney begins at 5 weeks of intrauterine life and continues up to the last monthof third trimester of pregnancy. [6] There are lobes on the fetalkidneys. Since there are more and larger nephrons during infancy, these lobulations typically go away. Nephron formation is finished at full term, and each kidney will have4 to 20 nephrons. The proximal convoluted tubules andincreased interstitial tissue both contribute to the kidney's growth in size after birth. Although glomerular filtration begins at 9 weeks of gestation, functional kidney maturation and an increase in glomerular filtration rates happen after birth. [7]

Various congenital kidney diseases like unilateral or bilateral renal agenesis, renal hypoplasia, renal hyperplasia, autosomal recessive polycystic kidney disease, horseshoe kidneys, malrotated kidneys, ectopic kidneys, hydronephrosis, multicystic dysplastic kidney disease are due to changes in the normal developmental sequences of the kidney. [8] The etiopathogenesis of many adult kidneydiseases are also enrooted in the events those occurringduring the intrauterine development of fetus. [9] Anatomical microdissection as well as histogenesis and nephrogenesisof human fetal kidneys showing the various developmental sequences of kidneys have been studied by some researchers before many decades as well as in the recent past. [10-12] This can further be explained if these developmental sequences of the kidneys are studied thoroughly in detail. Renal medulla was having loose connective tissue with mesenchymal cells. At 18- 25 weeks, nephrogenic zone wasreduced, glomeruli were bilobed and more in number. Proximal convoluted tubule was having irregular lumen lined by cuboidal cells with brush border and having euchromatic nuclei. Distal convoluted tubule was having large lumen lined by cuboidal cells without brush borderand having euchromatic nuclei. At more than 25 weeks, thickness of cortex and medulla were inceased withincrease in gestational age. In medulla, the number of collecting tubules, thick and thin limbs of loop of Henle were increased. [13] In the present study, the morphological data denoting the various embryonic developmental stages of human fetal kidney were collected and tried to establish the correlation of the same with the gestational age of the fetus and further the histogenesis of the human fetal kidney was also studied in the Indian population.

Material and Methods

Comparative study- This study was carried out in the Department of Surgery in NMCH, Patna. The abortus/fetus used in this study were gathered from the Department of Surgery and Obstetrics and Gynecology. 40 fetuses between the ages of 14 and 40 weeks were gathered. The inclusion and exclusion criteria listed below served as the foundation for the selection of specimens.

Inclusion Criteria

- 14 to 40 weeks of pregnancy.
- Standard obstetric history.
- Clinical background accessible.
- Free from anomalies that can be seen or felt.

Exclusion Criteria

- Fetuses that have been aborted before 14 weeks ofpregnancy.
- Any obvious and discernible congenital abnormalitiesin the fetus.
- Clinical background unavailable.
- Prior to inspection, formalin fixation.
- Fetal hydrops.
- Congenital malformations present.
- Fetal or maternal infection.

Consent form was prepared in two different languages(Hindi and English) for better understanding of the parentsand near relatives. Once we receive information from sister-in-charge of labor room about availability of fetus, weimmediately rushed to the labor room. We have team of 3people including principle researcher, secondary researcherand one laboratory technician trained in histopathology lab who is aware about handling of freshly received specimen.

Primary Handling of the Specimen

Fetus collected in sterilized container after cutting umbilicalcord. Placenta was not the part of study, so we had notcollected placenta. Fetus collected from the labor roomwere brought to department of Anatomy and immediatelywashed in to tap water. After washing plastic coin withembossed number, had been attached to the specimen. Eachspecimen has been provided with unique ID. Instruments/Equipment required for study.

Special instruments must be used when performing a perinatal autopsy, because of the small size of the fetus. Ophthalmic instruments are excellent for these small dissections. Charts providing normal weights and measurements for newborns and still borns Sterile and nonsterile syringes and needles (multiplesizes) Sterile packs including scissors and forceps (tooth for-ceps, blunt forceps) for cultures and karyotype Stout scissors for cutting bone Small scissors with at least one sharp point (one).

The gestational age was estimated by measuring Crown Rump Length (CRL) and referring to the chart given in the text book of Human Embryology by Boyd, Hamilton and Mossmann.[14] Routine microscopic exam is an important part of the autopsy, particularly in well-preserved fetuses. The kidneys were procured and were processed for histological

examination with hematoxylin and eosin stain.[15]

Results

The total number of non-macerated cases studied was 40. Total 90 families were identified and asked for consent, out of which 30 families were refused permission for an autopsy.

Table 1: Group wise mean of FW, CRL, CHL and HC

GROUP	FW in gm	CRL in mm	CHL in mm	HC in mm
1	151.3	131	201.22	133.11
2	492.84	192.36	296.88	197.43
3	1022.12	183	352.2	209.07
4	2312.32	300.32	386.64	291.46

All the samples were divided into four groups as mentioned previously as group 1, 2, 3 and 4 which comprised of fetuses of the gestational ages between 14 – 18, 19 – 26, 27 – 32 and 33 – 40 weeks respectively.

Table 2: Group wise fetal weight and fetal kidney weight

Group	Age of fetus	Mean FW	Mean RK weight	Mean LK weight
1	14 – 18 weeks	148.4	0.56	0.62
2	19 – 26 weeks	422.81	1.33	1.52
3	27 – 32 weeks	1022.12	5.49	4.35
4	33 – 40 weeks	2312.32	10.02	12.51

Table 2 shows the mean fetal weight and means of weight of right and left kidneys as per the group distribution. It was observed from the data that the rate of increase in the fetal kidney was high during the early stages of the development. In the first 3 group, there was almost 3 times increase in kidney weight in each group. During the last weeks of the gestational period, 33 – 40 weeks, the increase in the weight of the kidneys slow down as compared to earlier gestational weeks, which isin contrast to what is observed in the fetal weight.

Table 3: Group wise right fetal kidney parameters

Group	Mean RKweight	Mean RKLength	Mean RKwidth	Mean RK thickness	Mean RK circumference
1	0.56	11.29	4.21	5.66	21.35
2	1.33	18.7	11.22	8.58	20.42
3	5.49	24.42	15.00	09.77	51.17
4	10.02	36.06	20.12	11.33	58.15

Table 4: Group wise left fetal kidney parameters

Group	Mean LKweight	Mean LKLength	Mean LKwidth	Mean LK thickness	Mean LK circumference
1	0.62	12.42	4.11	3.06	21.36
2	1.52	18.24	10.67	07.22	20.10
3	4.35	21.00	14.53	08.85	48.38
4	12.51	20.17	12.56	13.32	63.29

Table no 3 and 4 show various morphological parameters ofboth of the kidneys individually. It was observed that the length, thickness and the circumference of the both thekidneys showed a steady rise over the period of gestational developmental age. The mean width of both the kidneys slows down in the growth as the gestation progresses. All the parameters of the right and left kidneys were closely comparable for any of the four groups identified in thepresent study.

Discussion

A total of 40 fetuses of gestational age ranging from 14 – 40 weeks were studied in the present study. Various morphological features of fetus like fetal weight, crown to heel length (CHL), crown to rump length (CRL) and head circumference (HC) were studied. The morphological features of both right and left kidney like weight, length, thickness and circumference at hilum were also studied.The fetal kidneys were also studied for the microscopicdevelopment. Phillips JB et al 2009 [16] studied the fetal kidney weights in the Australian population and presented the data of both thekidneys individually. When compared with the present data, the mean fetal weight for both right and left kidneys for the fetuses of age groups of 14 – 18, 27 – 32 and 33 – 20 weeks of gestational age in the present study was found to be higher than the same from Australian fetuses. But for the age group of 19 – 26 weeks, kidneys from the Australian fetuses were weighing higher than the present study Ram KS et al 2015 [13]

observed the similar pattern in the fetuses of 20 weeks of age. Patil S et al 2012 [17] noted the corticomedullary differentiation in the fetuses of 23 weeks of age which slightly differed from the findings of the present study. We observed this finding in the fetuses of 24 weeks of age. Sunitha V et al [18] documented the differentiation of the corticomedullary junction in the fetuses of 20 – 22 weeks of gestational age. As the age progressed from 19 to 27 weeks, the thickness of the nephrogenic zone was seen to be reducing to a thin strip in the present study. On the surface of the kidneys, the lobulation was well marked during the earlier stages of the fertilization which became less distinguished as the age progressed. These lobes were found to be separated only in the outer parts of the cortex. In the deeper part of cortex as well as in medulla, the lobes were seen to be fused with one another. This finding was well in accordance with the findings of Haldar A et al 2018 [19] and Daković-Bjelaković M et al 2005 [20]. In the fetuses of 18 weeks, no distinguished epithelium could be observed in the renal pelvis in contrast to the transitional epithelium noted by Sharma SS et al 2014 [21]. All five stages of developing renal corpuscles were observed in the developing cortex in the present study. The developing and immature corpuscles were seen to be lying nearer to cortex and according to the maturity, distribution toward the medulla was observed. This finding of the present study was well in agreement with Patil S et al.2012 [17]. In India, the length of the right kidney in the fetuses of all the gestational age groups of the Gujarati population was found to be higher than the southern Indian population. A similar trend was observed for the width of the right kidney in the fetuses of all the gestational age groups. A similar trend of the differences in the morphometric data was observed for the left kidney also. This shows that the right and left kidneys of the fetuses of the Southern Indian population to be slightly smaller as compared to the same population. The right and left kidneys of the Gujarati fetuses were found to be larger in various morphometric parameters than the same from the North Indian population for the fetuses of various age group. As observed in the present study, the various morphometric parameters of both the kidneys were closely comparable. The present study describes the various developmental stage of histogenesis of the fetal kidney in population. This would provide the reference particular to the population for the stages of development of kidneys. This information willalso be useful to analyze the growth pattern of the human fetal kidneys, particularly in defining the stages and severity of various congenital renal diseases like renal agenesis, hypoplasia or polycystic renal diseases. It wasconcluded that at 24 weeks of age the corticomedullary junction becomes evident and the PCT and DCT also become easily identifiable. The thickness of medulla and cortex keeps on increases as the age progresses. The nephrogenic zone disappears by the age of 36 weeks of gestation.

Conclusion

It was concluded that in the present study that fetal weightin the population is lower than the same from Nepal as well as Eastern India. Up to second trimester end, the Gujarati fetuses were found to be heavier than the American fetuses. At terms, the Dennis, the Australian and the Gujarati fetuses were comparable in weight. In the last trimester, fetuses of Gujarati population weigh lighter than the same from the French. Thus, the present study provides the extensive data of morphological parameters of normal fetus and fetal kidney development as well as the histogenesis of the fetal kidneys in the Gujarati population.

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