AMERICAN ACADEMIC PUBLISHER

INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

ISSN NUMBER: 2692 - 5206 Volume 6. No 02. February ,2026

MORPHOLOGICAL CHARACTERISTICS OF RENAL STRUCTURES IN NEWBORNS IN THE NEONATAL PERIOD

Izzatullaev S.A., Davronov S.F., Islamov Sh.E.
Department of Pathological Anatomy,
Samarkand State Medical University,
Samarkand, Uzbekistan
E-mail: shavkat.islamov.1972@mail.ru

Abstract

The aim of the study was to evaluate the morphological features of the renal structures of neonates who died in the neonatal period, taking into account the gestational age and the leading cause of death. A comprehensive macro- and microscopic analysis of renal tissue was conducted using morphometric methods. It was established that the kidneys of newborns are characterized by morphofunctional immaturity of the glomerular and tubular apparatus, pronounced variability in the degree of nephron differentiation, and high sensitivity to hypoxic-ischemic and infectious-toxic effects. In hypoxic conditions, glomerular collapse, capillary stasis, dystrophy and necrosis of the tubular epithelium, and interstitial edema were detected. In sepsis, signs of thrombovasculitis and diffuse inflammatory infiltration were noted. The obtained data are important for neonatology, pathological anatomy, and forensic practice.

Key words

newborns, neonatal period, kidney, morphology, nephron, glomerulus, tubules, hypoxia, sepsis, morphometry.

Introduction. The neonatal period (0–28 days of life) is a stage of intensive postnatal adaptation of organs and systems. The kidneys of newborns differ significantly from those of adults in their morphological structure and functional capabilities. Incomplete nephrogenesis, functional immaturity of the tubular apparatus, and specific microcirculation characteristics make renal tissue highly vulnerable to hypoxic, infectious, and hemodynamic disturbances [2,3].

Nephrogenesis in humans is completed by 34–36 weeks of gestation, which determines the morphological immaturity of the kidneys in premature infants. Under conditions of perinatal hypoxia, sepsis, or severe somatic pathology, structural immaturity of the nephrons contributes to the development of acute renal failure and exacerbates multiple organ dysfunction [5,7].

Studying the morphology of the kidneys of neonates who died in the neonatal period allows us to clarify the pathogenetic mechanisms of death and improve the objectivity of pathological and forensic diagnostics [1,8].

The aim of the study was to examine the morphological features of the renal structures of newborns who died in the neonatal period and to determine the nature of morphological changes in various pathological conditions.

Materials and Methods. The study sample consisted of kidneys from neonates who died in the neonatal period. Macroscopic and microscopic examinations were performed using standard histological processing (fixation in 10% neutral formalin, paraffin embedding, and hematoxylin and eosin staining).

Morphometry was performed using a digital microscope system at ×200 and ×400 magnification. The following parameters were determined: glomerular diameter; vascular loop area; cortical thickness; proximal tubule diameter; and relative interstitial tissue area.

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 6. No 02. February ,2026

Statistical data processing was performed using mean values (M) and standard errors (m).

Results. Macroscopically, the kidneys of newborns had a pronounced lobular surface. The average kidney weight in full-term infants was 10–12 g. The cortex was relatively wide, and the medulla was moderately differentiated.

Microscopic examination: Glomerular apparatus. In full-term newborns, glomeruli are predominantly formed, but variability in their size has been noted. In premature infants, a nephrogenic zone with immature nephrons was observed.

In hypoxic conditions, the following were observed: collapse of capillary loops; blood stasis; endothelial swelling; and expansion of the capsular space (Fig. 1).

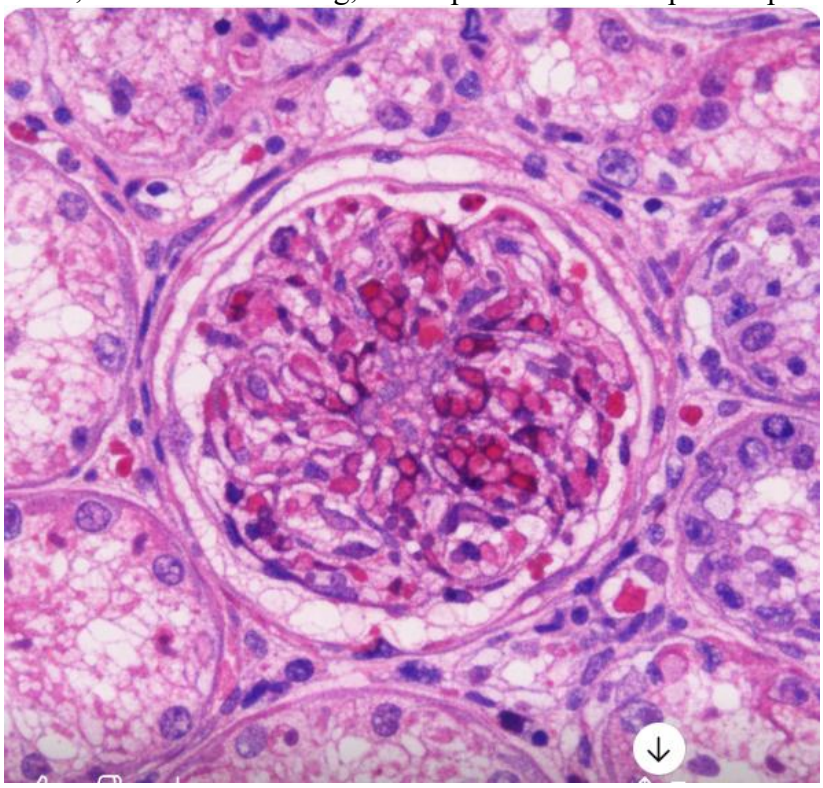

Fig. 1. Newborn kidney. Collapsed glomerulus and renal tubules. Hematoxylin and eosin staining. Magnification ×400.

A renal corpuscle with moderately variable capillary loop sizes is visible in the center of the visual field. The glomerular capillaries are locally congested, with stasis of blood cells. The lumen of the Bowman-Shumlyansky capsule is unevenly dilated. Podocytes are poorly differentiated, with hyperchromatic nuclei.

Proximal and distal convoluted tubules are visible in the surrounding interstitium. The epithelium of the proximal tubules is tall and cuboidal, with granular cytoplasm, locally showing signs of hydropic degeneration (vacuolization). In some tubules, desquamation of epithelial cells into the lumen is visible. The interstitial tissue is moderately edematous, and the microvascular vessels are dilated and congested.

The picture is consistent with hypoxic-ischemic renal tissue damage in a newborn, with predominant involvement of the glomerular apparatus and tubular epithelium.

Tubular apparatus. The proximal tubules were characterized by tall, cuboidal epithelium with a weakly defined brush border. Pathological conditions included: hydropic degeneration;

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 6. No 02. February ,2026

cytoplasmic vacuolization; epithelial desquamation; hyaline cast formation; and focal necrosis (Fig. 2).

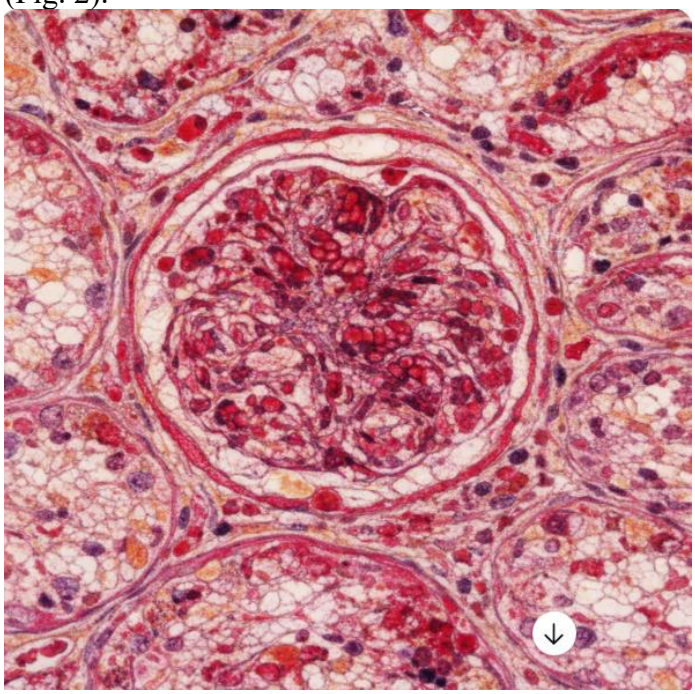

Fig. 2. Newborn kidney. Van Gieson stain. Magnification ×400.

Collagen fibers of the stroma and basement membranes are intensely red, while muscle and cytoplasmic structures are yellowish. Moderate thickening of the mesangial matrix is observed in the renal corpuscle region. Capillary loops are partially collapsed.

In the interstitium, increased collagen content is noted, particularly perivascularly. The arteriole wall is thickened, with signs of plasmorrhagia. The tubular epithelium is dystrophically altered in places, with some lumens containing eosinophilic proteinaceous masses.

Van Gieson staining allows for clear visualization of the stromal component and the detection of early signs of interstitial fibrosis and vascular remodeling characteristic of prolonged hypoxia or septic processes.

Vascular changes. Frequently detected were: venous stasis; microthrombosis; plasmarrhea; and signs of disseminated intravascular coagulation (DIC) in sepsis.

Interstitial changes. Marked edema, focal lymphohistiocytic infiltration, and dilation of the intertubular spaces were noted (Fig. 3).

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 6. No 02. February ,2026

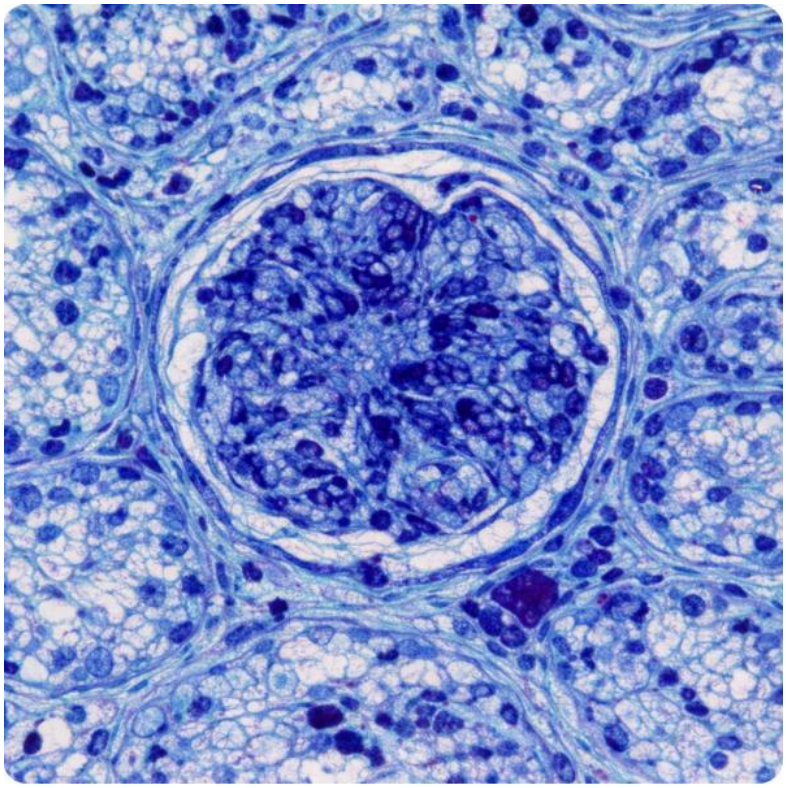

Fig. 3. Newborn kidney. Collapsed glomerulus in renal tissue. Stained with toluidine blue. Magnification ×400.

Cellular elements are intensely stained in various shades of blue. Epithelial cell nuclei are hyperchromatic and clearly delineated. The cytoplasm of the proximal tubules exhibits fine granularity and localized vacuolization.

The glomerulus is represented by capillary loops with signs of stasis. Mesangial cells are clearly visible, with moderate hyperplasia. The interstitial tissue is edematous, with isolated lymphohistiocytic elements.

Toluidine blue provides high contrast for nuclear and basophilic structures, allowing for assessment of the degree of cellular response, the severity of degenerative changes, and the condition of the mesangial apparatus.

The combined use of various histological stains allows for: objectification of the degree of nephron immaturity; identification of early signs of ischemic and inflammatory damage; assessment of the condition of the interstitial stroma and vascular bed; and increased diagnostic accuracy of pathological reports.

In hypoxic-ischemic lesions, a 20-35% decrease in the area of vascular loops and an increase in the relative interstitial area of up to 30-40% were observed (Table 1).

Table 1.

Morphometric parameters

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 6. No 02. February ,2026

Indicator	Full-term (M±m)	Preterm (M±m)
Glomerular diameter (µm)	85–100	60–80
Glomerular area (µm²)	5500–7500	3500–5000
Cortical thickness (mm)	3,0–4,0	2,0–3,0
Proximal tubule diameter (µm)	35–45	25–35
Relative interstitial area (%)	12–18	18–25

In hypoxic-ischemic damage, a decrease in the area of vascular loops by 20–35% and an increase in the relative area of the interstitium to 30–40% were observed.

Discussion. The obtained results confirm that the kidneys of newborns exhibit morphological immaturity, which is particularly pronounced in premature infants. The primary pathogenetic mechanism of injury is impaired microcirculation, leading to ischemia and degenerative changes in the tubular epithelium. Septic conditions are accompanied by thrombovasculitis and severe inflammatory infiltration, which aggravates renal dysfunction. Morphometric analysis allows for the objectification of the degree of structural changes and the use of quantitative criteria in formulating pathological reports [4,6].

Conclusion. The kidneys of newborns are characterized by morphofunctional immaturity of the nephron apparatus. Those who die in the neonatal period exhibit pronounced signs of hypoxic-ischemic and vascular damage. Morphometric parameters allow for a quantitative assessment of the extent of structural changes. The data obtained have practical implications for neonatology, pathological anatomy, and forensic examination.

References.

1. Avdeeva T.G. Forensic Medical Assessment of Kidney Damage in Newborns. – SPb.: SpetsLit, 2018. – 156 p.
2. Alyabyeva N.M., Lebedev V.V. Morphology of the Kidneys of Newborns // Archives of Pathology. – 2019. – Vol. 81, No. 3. – P. 45–52.
3. Baranov A.A. Neonatology. – Moscow: GEOTAR-Media, 2021. – 864 p.
4. Kulikova N.V., Smirnov I.A. Hypoxic Kidney Damage in Newborns // Pediatrics. – 2020. – № 5. – P. 78–84.
5. Faa G., Gerosa C., Fanni D., et al. Morphogenesis and molecular mechanisms involved in human kidney development // J. Cell. Physiol. – 2019. – Vol. 234. – P. 14816–14825.
6. Rodríguez M.M., Gómez A.H. Development of the human kidney // Pediatr. Dev. Pathol. – 2018. – Vol. 21. – P. 1–14.
7. Selewski D.T., Charlton J.R. Acute kidney injury in neonates // Clin. Perinatol. – 2022. – Vol. 49. – P. 247–263.
8. Sutherland M.R., et al. Nephron number and renal disease risk // Nat. Rev. Nephrol. – 2020. – Vol. 16. – P. 593–610.