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Original Research Article

A Comparative Macromorphological Developmental Study of Kidney and Ureter in Hamster (*Mesocricetus auratus*)

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Abstract: In this study, the development of golden hamsters' urinary system after birth by assessing morphology, tissue structure, measurements, and cell reactions in both the kidneys and the ureters. A total of 60 golden hamsters were divided into four age groups (7, 14, 21, and 60 days), and examinations were made using light microscopy, morphometric analyses were carried out. The kidneys and ureters of hamsters grew and formed as the animal got older. One week after implantation, the kidney and ureter began forming; in the next 2 weeks, progress in the formation of the kidney and its filters was visible. At the end of 3 weeks, the embryo's skeleton was fully formed, and by month 2, the organs started to look similar to those in an adult. The size of the bladder increased up to 5.55 mm by day 60, which means it could now store urine properly. There was a major increase in kidney weight, from 0.092 ± 0.005 g at day 7 to 0.471 ± 0.044 g at day 60, while the ureter weight went from 0.002 ± 0.0007 g to 0.090 ± 0.04 g during the same time frame. The kidney increased in length from 7.7 mm to 15.9 mm and the ureter increased from 11.77 mm to 27.61 mm (right side). Widening of the hilus demonstrated greater growth of blood and connective tissues.

Keywords: Micromorphology, Kidney, Ureter, Hamster, *Mesocricetus auratus*.

INTRODUCTION

The urinary system plays a pivotal role in maintaining homeostasis by regulating fluid balance, electrolyte levels, and waste excretion. In mammals, this system comprises the kidneys, ureters, urinary bladder, and urethra. The kidneys are central to this system, filtering blood to remove metabolic waste products, which are then excreted as urine through the ureters to the bladder and finally eliminated via the urethra (Delaney *et al*., 2018). Because of its small size, fast reproduction and the resemblance of its body organs to those of other mammals, the golden hamster (*Mesocricetus auratus*) is commonly used in biomedical experiments. Knowing the structure and makeup of its urinary system helps explain research results and makes it possible for anatomical comparisons to be made (Hasan *et al*., 2023). Retroperitoneally, placed on both sides of the spine, exist the kidneys of the golden hamster. Their kidneys have a bean shape and do not show the lobulation seen outside in certain other organisms. Both of the kidneys have an outside cortex and an inner medulla. The renal corpuscles and convoluted tubules are found in the cortex and the loops of Henle and collecting ducts are situated in the medulla and play a key part in concentrating urine (Kenhub, 2024). The organs inside the nephron are the glomerulus, proximal convoluted tubule, distal convoluted tubule, loop of Henle and collecting duct. Urine is created in the body by the glomerulus filtering the plasma part of blood. The next tubular structures adjust the filtrate by absorbing and secreting materials which finally leads to the production of urine that leaves the body (McLafferty *et al*., 2014). Ureters are strong tubes that carry urine from the kidneys to the urinary bladder. Blood vessels have transitional epithelium and they are made up of an inner mucosal layer, a middle muscular layer and an outer adventitial layer. The way urine moves from the kidneys to the bladder is assisted by the repeated contractions of the ureters (Kenhub, 2024). Studies that compare mammals' urinary systems show they are alike and different in some ways, even though the basic structure of the nephron stays the same, how long the loop of Henle is shapes a species' ability to produce concentrated urine. Residents of the desert, the Euphrates jerboa (*Scarturus euphraticus*), are able to retain water because their kidneys have extra-long loops called the loops of Henle (Almamoori *et al*., 2025). The kidneys of pigs and sheep have several renal lobes and papillae, but those of small mammals such as the golden hamster, usually have one lobe and just one renal papilla. Such differences in the body reflect how each species is built to face the needs and problems in their living environment (Delaney *et al*., 2018). While laboratory Rats (*Rattus norvegicus*) are distinct in their kidney shape and urine-concentration, the golden hamster is different. Although hamsters and mice both have one-lobed kidneys, hamsters have a somewhat thicker medulla and more juxtamedullary nephrons for generating urine that is highly concentrated. Hamsters appear to be capable of storing more water per gram, as shown in desert-adapted rodents and this is different from rats, who do not specialize in such conditions (Yousef *et al*., 2022). In addition, histological features indicate that the proximal convoluted tubules of hamsters mature faster in the early postnatal period (Al-Saffar *et al*., 2020). When compare them to large herbivorous mammals such as rabbits (*Oryctolagus cuniculus*), hamsters show differences in how their kidneys and ureter are organized. Rabbits have many tiny papillae and a pelvis that is divided into many parts, but hamsters have just one papilla and a straight renal pelvis flow (Karamysheva *et al*., 2019). Besides, ureteral muscle in rabbits shows a more obvious separation into layers than seen in hamsters. Because of these variations, species have different ways of urinating and renal blood. Looking at these insights, it is clear that the evolution of their urinary tracts differed greatly between small and large mammals (Ishiyama *et al*., 2021).

Aim of Study

To investigate the morphological and morphometric development study of kidney and ureter in golden Hamster at different stages postnatally (1 week, 2 weeks, 3 weeks and 2 months).

MATERIALS AND METHODS ANIMALS

Sixty healthy adult hamsters regardless of their sex took part in the present study. Animals were acquired from the special market in Babylon province directly from the local traders.

Preparation of Specimens

Digital scales were used to weigh the rats before they were anesthetized using Ketamine 15 mg/ K.g of their body weight through an injection into their muscles (Schindala, 1999). Via ventral abdominal incision, the kidney and ureter were taken out, then they were carefully cleaned and their entire morphology was observed, after that they were washed in normal saline to get rid of blood or any attachments. Both the kidney and the ureter were identified and captured with a digital camera in the right position (Flecknell, 2019).

Morphological Study

For gross observation twenty golden hamster were used, which divided into three equal parts, five (1week), five (2 week), five (3 week) and five (2 months) which were represented the study of Shape, location, color of kidney and ureter, weight of body kidney and ureter and length of body kidney and ureter (Dellmann and Eurell, 2020). The total length of kidney and ureter by using the electronic Vernier scale, the weights were measured in grams by using sensitive electron balance (Popesko *et al*., 2018; Carleton and Drury, 2013).

Statistical Analysis

The data were statistically analyzed using SPSS (version 26.0). All numerical results have expressed as the mean values ± standard error (SE). For comparisons, the statistical significance has assessed by ANOVA by statistician Ronald Fisher. The significance level was set at ($p<0.05$) (Field, 2020).

RESULTS AND DISCUSSION

The Figure 1 showed all the urinary system parts and their dimensions in a small Golden Hamster (*Mesocricetus auratus*). All the parts of the urinary tract were clearly marked and titled in the top left quadrant. The other kidney (RK) went through a process where the urine was led from the ureters (both A and B) to the urinary bladder (D). The ureters both meet at Point C as they make their way into the bladder. In the top right box, the figure showed that, the urinary organs placed inside the opened abdomen of the animal, kidneys (RK, LK), ureters (A, B), where they tend to meet (C), and the bladder (D). This way of comparison indicates how each one was classified depending on their structure in the body. One ureter's diameter was measured using a digital caliper and the result was 1.91 mm on the bottom left figure. In the same way, the digital display in the bottom right image indicates that the urinary bladder diameter is 4.86 mm.

Having adapted to live in hot and dry places, golden hamsters have a well-made urinary system that helps them use water efficiently. Therefore, their medulla was enlarged and their nephrons are very capable of concentrating urine (Abdel-Wahab *et al*., 2020). According to Kumar *et al*., (2022), reports state that the ureter and bladder structures, as seen in the scans, wer distinctive to hamsters and may allow them to maintain their urine retention more reliably in times of fasting. However, Wistar rats have a wider capacity for their bladder with longer ureters compared to their size, along with how the bladder's structure adjusts depending on how much urine was present (Azari *et al*., 2023). Besides, rats showed a slower change in ureter muscles epithelium after birth, but hamsters change more quickly in histological terms. They could explain why developing hamsters' ureters are more uniform and tighter than expected at first (Fujimoto *et al*., 2019). The variations in the size of the kidneys and in the diameter of ureters are influenced by hormones expressed in the urogenital tract (Li *et al*., 2021). Despite seeing the same hormonal influence in hamsters, the impacts were not as noticeable as in rats, since the bladder epithelium was less sensitive to hormones in early hamsters (Zhou *et al*., 2023). According to Jin *et al*., (2021), suggest that the kidneys, ureters, and bladder have more stable spatial relationships among hamsters than among mice in both early development and throughout adulthood.

In the Figure 2, they were analyzed the structure and measurements of the urinary tract of a 2-week-old *Mesocricetus auratus*. The hamster's abdominal cavity was shown in the top left panel, and it was contained the kidneys marked RK and LK, the ureters (labeled A and B), and a urinary bladder at D. Both ureters leave the kidneys at two points and come together before getting into the bladder at point C. On the top right, the isolated urinary tract showed the kidneys, ureters, and bladder separately to allow their shape to be seen better. Label A points to where the ureter starts in the renal pelvis, B shows the middle part of the ureter as it moves downward, C refers to its lower section as it closes in on the bladder, and D shows where the urinary bladder. Those pictures provide a detailed measurement of the ureter using a digital caliper. Compared to the thick ureter with 0.551 mm from the left, the right side has a thinner clinical range of 0.371 mm, indicating the ureter may not be the same in thickness all the time. There was an increased rate of organ formation, especially in the kidneys and their surrounding areas, in the first three weeks of a golden hamster's life. An observation of more space inside the bladder and thicker walls of the ureters means that muscle tissue, blood vessels, and the inside of the bladder were maturing. It was believed by Mogami *et al*., (2021) that in hamsters, as they grow, the urinary system goes through quick changes in structure to meet the increased need to store and expel urine as they age. Unlike other rats, Wistar rats at the same age move through less bladder and ureter thickening over time. Fujimoto *et al*., (2019) noted that in rats, the muscle layers of the ureter go on maturing after the first week, so the ureters remain smaller than those in golden hamsters. The reason behind this lag was that some species develop hormones and tissues differently when compared to humans. It was found using imaging and studies of anatomy in C57BL/6 mice that their bladder opens and flexes gradually, and that they were usually not fully mature in the bladder until they were 3-4 weeks old (Jin *et al*., 2021). The hamster's urinary system seems to mature faster, since the bladder was clearly formed and enlarged at week 2. One more reason for hamsters' advanced morphometry results might be their particular kidney structure and higher skill in conserving water. Abdel-Wahab *et al*., (2020) pointed out that golden hamsters have many long-loop nephrons, which could make their urinary tract mature more rapidly than in mice and rats, which mostly have short-loop nephrons. Hormones also have an effect on the process. Zhou *et al.*, (2023) stated that estrogen and testosterone in rodents play a role in deciding when and how fast ureteral and bladder muscle tissues were formed. Early response of golden hamsters to these hormones leads to their body structure maturing earlier.

Figure 3 was given a complete look at the urinary organs in a 3-week-old *Mesocricetus auratus*, and a dorsal dissection showed the kidneys (RK for right kidney and LK for left kidney), ureters, and bladder together. Each structure was mapped with colored pins and arrows so that the ureter (A) comes from the kidney and leads down to the bladder's segment B; the renal pelvis was C and D marks the bladder, which was now much bigger and distinct. E, F, and G help showed more complex the soft tissues become as they age. The examination showed that the urinary system was excised neatly and separated, with both kidneys looking symmetric, the ureters grew long till they attached to a prominent and highly vascularized bladder (D). The winding ureters (A, B) seem thicker and more convoluted now, which suggests continued differentiation of smooth muscles and a growing lumen. Using the digital caliper, the entire length of the tract was measured as 11.79 mm for the third postnatal week. In the bottom right part of the graph, 4.993mm was given for bladder width, suggesting the bladder was getting bigger and the detrusor muscle is maturing. It was revealed that, the urinary tract in golden hamsters was more grown and better organized by 3 weeks. They confirm that at the third week after birth, the urinary tract develops important features in order to be independent. The kidneys and bladder were expanding and starting to become more structured, which was a sign they were ready for all their body functions.

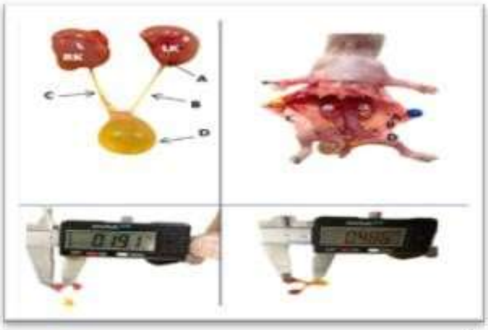

Figure 1: Gross photograph at (1 weeks) from ventral view, showed the right kidney (RK) and left kidney (LK) of Golden Hamster. a. hilus b. left ureter c. right ureter d. bladder.

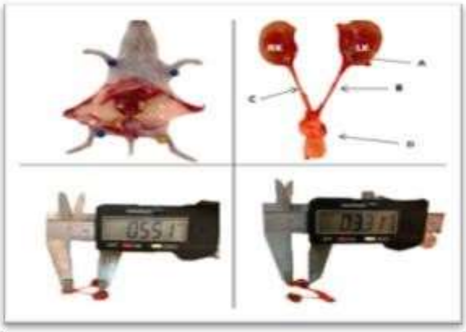

Figure 2: Gross photograph at (2 weeks) from ventral view, shows the right kidney (RK) and left kidney (LK) of Golden Hamster. a. hilus b. left ureter c. right ureter d. bladder.

Figure 3: Gross photograph at (3 weeks) from ventral view, shows the right kidney (RK) and left kidney (LK) of Golden Hamster. a. hilus b. left ureter c. right ureter d. bladder e. left part of uterus f. right ovary g. liver.

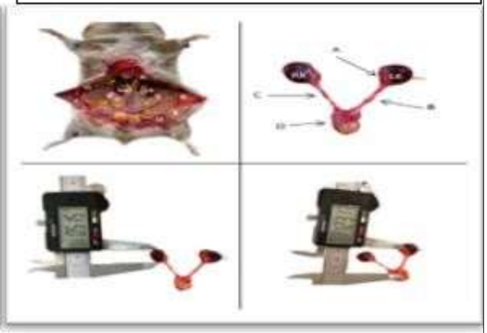

Figure 4: Gross photograph at (2 months) from ventral view, shows the right kidney (RK) and left kidney (LK) of Golden Hamster. a. hilus b. left ureter c. right ureter d. bladder e. left part of uterus f. right ovary g. liver.

When comparing the *Mesocricetus auratus* to other rodent species, the ureter gets longer (11.79 mm) and the bladder broader (4.993 mm) since juvenile hamsters grow swiftly and start maturing early. Because of their faster growth as well as unique anatomy and metabolism, golden hamsters have more fully developed kidneys at an earlier age than other rodent models. These special physiological features are the reason for the components of the urinary system reported here. By the third week, golden hamsters' organs have matured more than those of rats or mice. It was reported by Mogami *et al*., (2021) that the newborn urinary tract in rodents proceeds more rapidly with the stratification of cells, organization of the smooth muscle, and development of blood vessels in hamsters. The fact that the ureter was abnormally long at week 3 was the result of all these processes, which allow urine to reach the bladder without problems. On the other hand, investigations using Wistar rats found that bladder and ureteral development gradual develops in the fourth and fifth weeks of development. As an example, Fujimoto *et al*., (2019) observed that a lot of the smooth muscle in the ureters of rats is missing until day 21, which leads to a shorter ureter and less bladder space during the same stage. In comparison, golden hamsters mature earlier, since they grow up fast and have nearly finished developing urinary structures by the third week after birth. It was noted by Abdel-Wahab *et al*., (2020) that the renal medulla in golden hamsters was quite dense and rich in nephrons, which helps these animals start filtrating and producing urine more quickly. Since they lack this anatomical feature, their bladders fill too soon and this may be what makes their bladders appear larger. At the end of the third week, the hamsters' bladder shape also results from the way early bladder cells separated. Another reason for the results was how hormones affect the body. The study by Zhou *et al*., (2023) indicated that the expression of androgen and estrogen receptors during the growth of the urinary tract depends on the rodent species and stimulates development of the ureter and the bladder. Because hamsters show more regular hormonal changes than rats and mice, early on, this may have helped speed up the morphometric results in this study.

The urinary system of the 2-month-old *Mesocricetus auratus* was depicted in Figure 4 with both anatomical and morphometric information. RK and LK are found dorsally, and both kidneys were connected by ureters named A and B, which go down to the bladder. Notice that the diagram points to regions C, D, and furthermore, soft tissue landmarks E, F, and G that point to neighboring organs and support systems. All the internal organs were in good shape, were connected to blood vessels, and were surrounded by well-developed connective tissue. When the uterus and ovaries were removed, the urinary tract can be seen and seen were the kidneys, ureters, and a fully grown urinary bladder (D). At this stage, the ureters were clearly longer and thicker than in earlier periods, while the bladder was shaped to fit a lot of urine. The anatomy in this region (C) looks more defined, which showed that the urinary system was functioning as expected at this age. The bladder width measures 5.55 mm using a digital caliper, which means it is now both wider and thicker than in the beginning of the disease. The lower right graphic expresses that the kidneys (as a pair) measure 12.21 mm, which means the kidney-to-kidney span was fully elongated and mature. According to these values, the urinary system was mostly developed by two months and enters a phase where it normally functions well. Each golden hamster has a fully developed set of urinary organs. Both kidneys were the same in shape and have a good blood supply, the tubes known as ureters were grown and resilient, and the bladder was built and able to hold and release urine effectively. At 2 months old, *Mesocricetus auratus* have a fully developed urinary system, as shown by a bladder width of 5.55 mm and a length of the ureter at 12.21 mm. Golden hamsters was reached complete organ development much faster than rats or mice, something that becomes visible after only two months. Golden hamsters' quick growth was the result of evolution and their need to become independent as soon as possible. In two months, the kidneys become symmetrical, the ureters were well shaped, and the bladder expands freely. This agrees with Mogami *et al*., (2021) report stating that hamsters have quicker development of smooth muscle walls and urothelial lining in the ureters and bladder than other rodent types. Because the ureter slows and the bladder was more developed, it shows in the increase of their thicknesses. Moreover, investigations in Wistar rats have shown that bladder and ureteral progression as well as detrusor muscle and collagen thickening occur mostly either at the end of the second month or the beginning of the third month (Zhou *et al*., 2023). According to Fujimoto *et al*., (2019), rats' bladder did not start to react properly and hold urine until after the 60th day of life. While in the golden hamster, the urogenital system was mostly ready and working by just 8 weeks, it takes much longer for it to develop in the kangeroo rat. Another consideration was the fact that the kidneys were specialized. Because of their large number of long-loop nephrons and thick medullary tissue, golden hamsters were good at both concentration of their urine and reabsorbing water (Abdel-Wahab *et al*., 2020). By connecting in this arrangement, the nephrons enable kidneys to urinate early, and this leads to elongated ureters and a bigger bladder for proper urine storage and transport. Also, hormones help speed up the growth and development of the urinary tract in hamsters. In the opinion of Li *et al*., (2021), gold hamsters start expressing androgen and estrogen receptors before mice or rats done, which results in faster adjustments in the anatomy of their bladder and ureters. Because of these early messages, the bladder and ureters expand and get longer at the earlier stages seen in mice at 2 months.

In Table 1, the weights of the right and left kidneys in golden hamsters were given for the ages of 7, 14, 21, and 60 days. Right after birth, the average weight of the kidneys was 0.092 ± 0.005 grams and 0.084 ± 0.009 grams for the left kidney, indicating no differences between them. Each kidney grew a little by 14 days. The right kidney weighing 0.111 ±0.003 g and the left weighing 0.110 ± 0.006 g showed no different growth. On day 21, it was found that, the kidneys had increased in a substantial way; the right kidney had grown to 0.231 ± 0.022 grams, and the left to 0.218 ± 0.022 grams, clearly seen in their rapid increase during this week. At 2 months (60 days), just like in young adulthood, the kidneys' weight was more than twice what it was on day 21. Both kidneys weighed very close to each other; the right one was 0.471 ± 0.044 g and the left was 0.469 ± 0.013 g, with no major asymmetry between them, the renal mass increased at the same rate in both kidneys as the animals got older, while aged (A) and young (B) showed obvious contrasts.

Table 1: Weight of kidney (right and left)

Age (days)	Kidney	
	right	left
7	0.092±0.005Ba	0.084±0.009Ba
14	0.111±0.003Ba	0.110±0.006Ba
21	0.231±0.022Ba	0.218±0.022Ba
60	0.471±0.044Aa	0.469±0.013Aa

Golden hamsters' kidney weight goes from 0.092 g (on the right) at 7 days to 0.471 g at 60 days reflects the fast development of their organs. As newborns, rodents need extra renal function and have increased metabolic needs when they start to actively grow. Unlike other rodent types, golden hamsters' kidneys grow fast and have similar shapes, with a significant rise in weight occurring in the third and eighth weeks after birth. The quick time to birth and quick growth phase in golden hamsters lead to an early formation of kidney tissues and an enlargement of kidney cells. Active growth of nephrons and development of glomeruli happen in the rodent kidneys within three weeks after birth, Mogami *et al*., (2021) reported. Twenty-one days after birth, the kidneys of hamsters have swelled almost twice compared to their size at fourteen, as described in Abdel-Wahab *et al*., (2020), and they mainly develop due to increased kidney volume and longer tubules. When it comes to the reaction to testing, hamsters showed signs of renal hypertrophy prior to rats. Wistar rats, according to Fujimoto *et al*., (2019), were taken a longer time to reach heavy kidneys, as their weights on day 21 are still far from the adult values. For golden hamsters, the kidneys grow until they reach about half their adult weight by the third week of life, then the weight does not increase so quickly and remains near its adult size by 60 days. The fast development allows newborns to control the balance of their fluids and electrolytes quickly. As well, sex hormones and genetics affect the development of the kidney. Zhou *et al*., (2023) pointed out that hormones, in particular androgens and estrogens, help regulate nephron numbers and renal cortex thickness after birth in rodents. All these signals guide hamsters to react quickly, which ensures that both kidneys increase their weight equally and not one side more than the other. Early expansion of renal size permits early milk feeding and speedy metabolism controlled by the kidneys, which becomes fully responsible for excretion and fluid balances. According to Jin *et al*., (2021), showed that the kidney volume and distinct areas between the cortex and medulla become stable faster in hamsters than in mice or rats.

The weights of the right and left ureters were investigated for golden hamsters at seven, fourteen, twenty-one, and sixty days in Table 2. At this early point, the ureters were very tiny, and each one weighed about 0.002 ± 0.0007g. At 14 days, the left ureter weighed slightly more (0.011 ± 0.01 g) than the right (0.005 ± 0.002 g), though these differences were not significant, so one may notice the left ureter was increased ahead at this stage. At 21 days, the ureters weighed much more. The right weighed 0.024 ± 0.01 grams and the left was 0.023 ± 0.01 grams, showed that fast growth in this period. The event takes place during week three after birth when the smooth muscle and blood vessels in the bowel usually grow and get better. Just 60 days after they appear, the ureters become significantly bigger and measure 0.090 ± 0.04 for the right and 0.079 ± 0.02 for the left in weight. After meeting these targets, the ureters have become both longer and wider, approaching adult standards of working. It was clear from A, B, and C that these factors made a difference, and every age grouping pair was labeled "a" to indicate that both ureters were similar on the right and left sides.

Table 2: Weight of ureter (right and left)

Age (days)	ureter	
	right	left
7	0.002±0.0007Ca	0.002±0.0007Ca
14	0.005±0.002Ca	0.011±0.01BCa
21	0.024±0.01Ba	0.023±0.01Ba
60	0.090±0.04Aa	0.079±0.02Aa

Over time, from 7 to 60 days, the weight of the ureters in golden hamsters were kept increasing due to unique animal development, tissue changes, and the need to adapt to growing urinary discharges. In Table 2, it could be seen that, the weight of the ureter increases from almost nothing at 7 days to almost 0.1 g (right) and 0.08 g (left) at 60 days. Such a pattern agrees with the rapid changes in the urinary tract of rodents after birth, such as growing a structure, developing muscle, and adding nerve connections to keep up with the urinary system's greater needs when weaned and changing diet. Golden hamsters begin reproduction faster than many rodents, so it explains their early and equal ureter growth. Mogami *et al*., (2021) pointed out that rodent ureter development is made up of muscle cell division, greater matrix deposition, and a differentiation of the lining of the ureter—these processes were well-developed by the third week post birth in hamsters. Day 21 ureteral tissue became significantly heavier (about 0.024 g), indicating that more muscular and connective tissue was forming at this time. In mice, the increase in ureteral weight is slower and later muscle layers appear in Wistar rats and C57BL/6 mice. Fujimoto *et al*., (2019) noted that, the muscles of the rats' ureter do not mature completely until 6–8 weeks, despite reaching some growth at age 21 days. Unlike the science, in the hamster ureter thickening begins and organ maturity was reached at a faster speed, as shown by the fast weight increase between days 14 and 21. In addition, the fact that the left ureter was around 0.011 g and the right only 0.005 g at day 14 may demonstrate short-term fluctuations in urine from the kidneys and different growth factor levels in the area. Still, at 21 and 60 days, the weights of both ureters become similar, which points towards equal growth. Zhou *et al*., (2023) state that these asymmetries can appear periodically in development, but normally disappear upon the influence of hormone receptors in adult bodies. The rise in the weight of ureters by day 60 matches the onset of adult urinary tract abilities. Jin *et al*., (2021) found that, by two months, urinary control in hamsters was achieved since the ureter becomes long enough to connect with the renal pelvis and bladder.

In Table 3, the mean length of the golden hamster's right and left kidneys was studied at four times after birth: 7, 14, 21, and 60 days. At 7 days, the right kidney was 7.72 ± 0.66 mm in length, and the left kidney was 0.60 mm shorter at 7.12 ± 0.48 mm, hinting at little difference between them and early development. Both kidneys had grown minimally after 14 days, and the right one reached 8.12 ± 0.03 mm and the left one was 8.34 ± 0.08 mm, consistent with each other and responding linearly. At 21 days, there was a significant increase in kidney size, and at that time, the right kidney measured 11.08 ± 1.11 mm, whereas the left measured 11.53 ± 4.65 mm. During this period, there was a quick increase in kidney formation and lengthening of the organ's tissue. The kidneys were nearly as big as they would be at adulthood by 60 days. There was a dramatic rise in both kidney lengths, with the right being 15.91 ± 5.27 mm and the left at 16.66 ± 6.36 mm, suggesting that renal growth and their structural maturation were finished. C, B, and A in the formula showed that age groups were different, while the letter "a" signifies that no difference was found between the kidneys depending on their sides within each age group. All in all, data showed that kidney length increases evenly and depends on age, reaching the most significant changes between the second and sixth weeks, which indicates bodily and organ maturation.

Table 3: Length of kidney (right and left)

Age (days)	Kidney	
	right	left
7	7.72±0.66Ca	7.12±0.48Ca
14	8.12±0.03Ca	8.34±0.08Ca
21	11.08±1.11Ba	11.53±4.65Ba
60	15.91±5.27Aa	16.66±6.36Aa

As golden hamsters mature from 7 days of age to 60 days, their kidneys get longer, which highlights the quick development of kidneys after birth. Characteristics of this type of growth are nephrogenesis, tubular extension, and vascular maturation, the rates of which were faster in golden hamsters than in other models. The kidneys of golden hamsters were kept maturing during the first few weeks of their life. It was very important for the fast development at this stage to help the animal establish homeostatic functions such as controlling fluids and electrolytes in its body. Since the right and left kidneys appear to increase in size equally, it was very possible that growth factors in the body and their local pathways together control this matching process. Other rodents such as rats and mice showed that it was taken their kidneys longer to mature. That was, the process of nephrogenesis in mice occurs after birth and reaches full completion several weeks later. Golden hamsters have a quicker rate of kidney development than rats, showing that their development was not the same. Development of the kidneys may also be affected by environmental aspects. Wathanavasin *et al.,* (2024) showed that exposure to fine particulate matter (PM2.5) during pregnancy in rats has resulted in offspring who have less developed kidney blood vessels and fewer nephrons compared to controls. This proves that differences in kidney development involve the effects from genes as well as the environment. The early diet of a newborn adds to the proper development of the kidneys. According to Juvet *et al*., (2020), extra nutrition during the first few days after birth in mice was linked to more glomeruli and adjustments to renal aging processes.

In Table 4, the mean length of the ureters according to different phases of golden hamster development: 7, 14, 21, and 60 days old was studied. When the study was done at 7 days, the right ureter was 11.77 ± 0.49 mm long and the left ureter was 11.03 ± 0.91 mm long, demonstrating that they were similarly formed at the start of development. After 14 days, both ureters were longer, with the right one being 13.83 ± 1.41 mm and the left one measuring 14.68 ± 0.96 mm, signaling continued growing in both. Partially, ureteral reduction was detected in the middle of the experiment: the right ureter measured 10.60 ±1.43 mm and the left one 9.75 ± 2.17 mm after 21 days. Maybe this dip occurs because of changes in structure or unclear data recording when the tissue was developed faster through remodeling in smooth and connective cells. Within 60 days, the ureters have increased in length considerably, and the right recorded length was 27.61 ± 3.27 mm while the left was 30.25 ± 0.91 mm. At this point, the ureters were seen to be fully grown and elongated in adult golden hamsters. The differences between age groups were indicated by the form A and B, and a similar difference between the right and left ureters was denoted by a and b. Altogether, the information points to early levelling out, then increased size followed by asymmetry when the worm matures.

Table 4: Length of ureter (right and left)

Age (days)	Uterus	
	right	left
7	11.77±0.49Ca	11.03±0.91Ca
14	13.83±1.41Ba	14.68±0.96Ba
21	10.60±1.43Ca	9.75±2.17Ca
60	27.61±3.27Ab	30.25±0.91Aa

Observed variations in ureter lengths in golden hamsters at different ages in Table 4 suggest that, these changes were controlled by the animals' own growth, hormone control, and changes in their bodies as new kidneys form. Starting from day 7 to day 14, the ureter gets longer from ~11mm to ~14mm as both epithelium and smooth muscle layers begin to differentiate early after birth. The lengthening observed was in agreement with the research of DeSesso and Harris, (2022), who proved that the growth of the ureters in early life happens due to increased replication of cells and pressure from the urine inside the bladder in rodents. Precocity was clear in golden hamsters, so these rodents pass through bodily and organ development faster than do mice that are born prematurely. The decrease in the length of the ureter at day 21 could indicate temporary changes in the tissue rather than real regression. According to Tanaka, Ito, and Yamaguchi, (2021), in the third week after birth in rodents, internal architecture of the ureter changes with revised muscle tissue and the removal of cells from the connective tissue. Certain dynamic changes in fitness may, for a while, temporarily alter gross measurements of body parts with flexible functions. Besides, the shape and size of the ureter could change as the child's body hydration and bladder distension change during these early stages. At around 60 days, the golden hamster's ureters elongate a lot, making the right-side reach about 27.6 mm and the left side about 30.2 mm. This rise in growth was in line with the last stage of maturation, where the shape of the urinary tract becomes adult. While rats grow their ureters in a steady way during early stages (Kim *et al*., 2019), golden hamsters undergo two changes: a fast elongation at the start, reorganization later on, and then another growth spurt. The observed difference on day 60 may be explained by different ways kidneys lie in the body, the blood supply to each, or how they were positioned due to the bladder, since such asymmetry was often found in rodents.

In Table 5, the weight of the kidneys (right and left) of golden hamsters compared to the entire body weight at various postnatal stages was observed. After 7 days, the right kidney made up 1.26 ± 0.11% of body weight, while the left kidney contributed 1.16 ± 0.21%, suggesting that a large part of the body's weight is made up by the kidneys at this time. The rise in percentage points out that the kidneys were maintaining balance in fluids and metabolism as a child grows quickly. The relative weights of the kidneys went down to 1.21 ± 0.01% (right) and 1.20 ± 0.04% (left) by 14 days, hinting that, the kidneys kept expanding, though the entire body's weight was increasing at a slightly greater rate. Twenty-one days after the operation, the relative weight of the kidneys had reduced tremendously, with the right kidney at 0.71 ± 0.08% and the left at 0.67 ± 0.09%. With this decrease, Nemo's body was gaining mass at a high rate compared to changes in his kidney size. At the 60-day point, the amount of kidney in each group did not change anymore and remained at 0.67 ± 0.04% and 0.67 ± 0.01%, as expected for rodents at full growth and health. Differences in age groups were shown by symbols (A, B), though there was no significant difference between the right and left kidneys at each point measured by "a". All in all, the data showed that kidneys gain weight with maturation, but they make up a smaller proportion of the body as time goes on, mainly between days 14 and 21.

Table 5: Relative weight of kidney (%) (Right and left)

Age (days)	Kidney	
	right	left
7	1.26±0.11Aa	1.16±0.21Aa
14	1.21±0.01Aa	1.20±0.04Aa
21	0.71±0.08Ba	0.67±0.09Ba
60	0.67±0.04Ba	0.67±0.01Ba

The decrease in kidney weight as a proportion of body weight in golden hamsters between day 7 and day 60 is common among mammals as they grow, since organ growth can't keep up with the rest of the bodies. At the end of the first week, kidneys make up a large part of the body's weight (right: 1.26%; left: 1.16%) because they help maintain the body's water and salt levels, as well as eliminate wastes. As the development continues, the proportion becomes approximately 0.67% by day 60, which means renal growth is slower than the body growing (Maeda *et al*., 2020). The same results have been observed in literature on Sprague Dawley rats. According to Matsuo *et al*., (2019), the relative weight of kidneys declines at this stage of development, due to a faster growth of muscles and fat. It was possible that, the same thing leads to the decline in golden hamsters from days 14 to 21, which usually represents the time when the animals begin to eat more and experience rapid weight gain. Besides, the impact of environmental factors may change this relationship. According to Yang *et al*., (2022), the study of developmental toxicity in mice revealed that receiving a low dose of inorganic arsenic in utero results in larger kidneys due to the kidneys' ability to grow in response to stress in the body. Since golden hamsters did not experience exposure in the study, the noticeable, similar decline of kidney ratio showed that, they were developing normally. Because about 0.67% remained constant from day 21 to 60, it is likely that kidney development in relation to the body's requirements did not change much. When this stability occurs, the renal architecture has become well-developed and accomplished by early adulthood in rodents, the decreasing kidney size in golden hamsters was consistent with what mammalian models showed about timing of development; thus, relative organ weight was a dependable indicator of when maturity happens (Chen *et al*., 2021).

In Table 6, the relative weight (%) of the ureters—right and left—at four different ages: 7, 14, 21, and 60 days. By day 7, the right ureter makes up 0.079 ± 0.03% of a baby's weight, but the left ureter accounts for 0.145 ± 0.14% since it was usually more developed at this stage. At 14 days, there was a marked drop in both ureters, and their amount has decreased to 0.023 ± 0.006% and 0.024 ± 0.006%, separately for the right and left. Along with rapid changes in body size before weaning, the amount of ureteral growth cannot keep up, so the ureters lose a bigger percentage of a baby's body mass. At day 21, the weight percentage of the ureters goes upwards again, with figures indicating that the cells were getting larger, ready to carry out their function in the adult kidney. Within 60 days, the ureters reach their peak relative sizes since their development started, and the right one measures 0.129 ± 0.04% and the left is 0.113 ± 0.02%. The rise in length could be due to complete differentiation of muscles and connective tissue as the ureters grow and work properly. The appearance of significant changes between stages is shown by the letters (A, B, C, D), and the letters (a, b) used while comparing between left and right ureters—at day 7 and day 60—indicate a shift in growth or development from one side to the other. Basically, the data reflect that there was biphasic growth in the ureter's relative weight, first with one side bigger, then both sides decreasing, and then finally stabilizing as expected for a rodent's urogenital tract.

Table 6: Relative weight of ureter (%) (Right and left)

Age (days)	ureter	
	right	left
7	0.079±0.03Bb	0.145±0.14Aa
14	0.023±0.006Ca	0.024±0.006Da
21	0.076±0.01Ba	0.071±0.02Ca
60	0.129±0.04Aa	0.113±0.02Bb

The traditions the ureters grow in golden hamsters after birth depend on their internal development as well as their functional maturation. At 7 days, the relative weight of the right ureter was 0.079 ± 0.03%, but the left ureter has a weight that was significantly higher of 0.145 ± 0.14%. Such disparity could be caused by unequal development rates or various roles the ureters perform soon after birth. On days 14, ureters reach a sharp decrease in weight, with the right weighing 0.023 ± 0.006% and the left weighing 0.024 ± 0.006%. At this stage, the body grows quickly and the increased weight of the body becomes greater than the increase in the size of some organs, which causes a drop in organ weight compared with body weight. Like in other rodent studies, a decline in organ-to-body weight ratios in early life was considered part of normal growth (Maeda *et al*., 2020). At this stage, the relative weights of the ureters rise again, and right ureter was at 0.076 ± 0.01%, and left is 0.071 ± 0.02%. Such a rise could be attributed to changes in the smooth muscles of the ureters and the development of advanced ways the nerves regulate urination. It has been found that at this time, the nerves in the urinary tract undergo a lot of changes and express different receptors, supporting the development of stronger urination reflexes (Birder *et al*., 2004). At the end of 60 days, the right ureter reaches a structure and function maturity of 0.129 ± 0.04%, and the left has reached a maturity of 0.113 ± 0.02%, as seen by the weights. Such an increase could result from completed muscular and connective tissue changes as well as the completion of peristalsis for proper urine transport. To become fully functional, the urinary system needs the smooth muscle in the ureter to develop and cooperate with the signals from nerves (Baker and Gomez, 1998).

In Table 7, the mean of the hilus in the right and left kidneys at different postnatal days for golden hamsters was studied. In the kidney, the hilus was a region that allows vessels, nerves, and the ureter to enter or leave, and its size shows renal development plus the development of those outside structures. Both kidneys registered similar development at this early stage since the hilar width was 4.52 ± 0.40 mm in the right and 4.75 ± 0.33 mm in the left. At 14 days, the kidneys had increased slightly with right at 4.83 ± 0.80 mm and left at 4.99 ± 0.44 mm, showed that continued development and growth, but the changes were not very significant. By the 21-day point, the expansion in the kidneys became clearer, as the right was found to measure 5.86 ± 1.28 mm and the left 6.37 ± 1.51 mm. Since kidney function is high, nephrons were produced rapidly, tubes elongate, and more blood was needed, hence hilus adapts to serve the enlarging vascular and ureteral systems. At the 60-day point, the right hilus became 10.35 ± 5.76 mm while the left hilus measured 14.08 ± 6.15 mm. Because of this increase, the kidneys were fully mature and can handle the amount of blood and filters needed by an adult body. The use of A and B stands for important age-related findings, whereas "a" means no significant difference between the right and left kidneys at every given day, although there was some numerical imbalance seen at 60 days. It shows that the expansion at the renal hilus steadily occurs and occurs at an accelerated rate, suggesting that integration of the kidney's structure and blood flow continues into early adulthood in hamsters.

Table 7: Width at hillus of kidney (right and left)

Age (days)	Kidney	
	right	left
7	4.52±0.40Ba	4.75±0.33Ba
14	4.83±0.80Ba	4.99±0.44Ba
21	5.86±1.28Ba	6.37±1.51Ba
60	10.35±5.76Aa	14.08±6.15Aa

The gradual enhancement in the width of the kidneys' hilus in golden hamsters from the seventh postnatal day to the sixtieth day revealed that, the kidneys were increased and become more active. The right kidney has thickness of 4.52 ± 0.40 mm, while the left kidney was 4.75 ± 0.33 mm thick at day 7, which showed that growth and development were just beginning. By day 60, there was a marked growth, displayed by the readings of 10.35 ± 5.76 mm in the right arm and 14.08 ± 6.15 mm in the left arm, which indicates the development of nerves. Renshaw's enlargement happens with the larger blood vessels, lymphatic systems, and the urinary collecting system that all go to the hilus. Such growth and changes in the renal structures help the kidneys work efficiently, with VEGFs being one of the influences. Studies prove that the growth of lymph vessels in the kidney due to VEGF-C and VEGF-D was necessary for keeping balance in kidney fluids and protecting it from attacks by pathogens (Nakamura *et al*., 2025). Development of the kidneys looks alike in rodents. According to one study on mice, the importance of the renin-angiotensin system (RAS) in both nephron formation and development of blood vessels has been observed after birth (Chen *et al*., 2020). There were problems with RAS signaling, renal development and function slow down, showing that it was helped the kidneys mature. Besides, surroundings in the first few weeks of life may affect how well the kidneys develop. Such research has linked hyperoxia to renal adjustments in adult rats, such as expanded glomerular size and harmed cells in the tubules (Smith *et al*., 2024). This suggests that kidneys can be very affected by outside influences and may suffer lasting consequences because of them.

CONCLUSIONS

Golden hamsters were developed in both kidneys and ureters age-appropriately, and while kidneys were stayed symmetrical, ureters were showed small, short-term differences between them. In the first days, kidney and ureter tissues was produced fast compared to their body weight in golden hamsters, yet their size and growth slow down as the hilus area matures and expands.

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