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Original Research Article

Learning from the Electronic-Rat: A Computer-Based Dissection Guide for Biomedical Researchers

Akunna G.G[1*], Nwafor J[1], Egwu O.A[1], Adepoju L.H[2], George I.O[1], Obaje S.G[1], Uzomba G.C[1]
[1]Department of Anatomy, Faculty of Basic Medical Sciences, Federal University Ndufu-Alike Ikwo, Ebonyi State
[2]Department of Anatomy, Faculty of Basic Medical Sciences, University of Nigeria, Enugu State

***Corresponding author**
Akunna G.G
Email: ggakunna@gmail.com

Abstract: The rat is a vertebrate and several aspects of its structural organization are common with human. The similarity of structures illustrates evidence of common ancestry. Computer-based instruction can be a viable tool for researchers who are not familiar with the anatomy of this fine specie. This is pertinent when one consider the increasing awareness of animal rights issues and ethnic/cultural sensitivities to whole animal and animal parts dissections. In this exercise, we aimed to provide high definition audiovisual and pictures of the neck, thoracic and abdominal and pelvic regions of the Rattus norvegicus with the aid of a Digital Camera (NUMY3GAX9 version 1.19-20140904), Happy Camper 12 LED and UCO Arka Rechargeable lantern, forceps, dissecting board, scissors, pins, wools, Tris buffer solution (pH 7.5) and chloroform. At the end of the exercise, apparent pictures and data-friendly MPEG4 audiovisuals of 8-30 minutes span were produced. The videos and pictures were crystal clear with organs, structures and vessels evidently outlined. The pictures and audiovisuals could offer supporting and reinforcing information for medical scientist and biologist. It could also serve as a tool to variety of learning experiences that target different learning styles for biology students.
Keywords: Rattus norvegicus, Dissection Guide, Computer-based simulation, Biology Education, Comparative Anatomy

INTRODUCTION

Rattus norvegicus has been a perfect experimental model for numerous scientists all over the world [1-12]. This is because several aspects of *Rattus norvegicus* structural organization are common with that of the humans. Computer-based simulation can be a viable tool for researchers who do not know their way through the anatomy of this fine specimen. Although traditional dissection creates tactical and lasting impression, computer-based simulation materials can offer a large amount of supporting and reinforcing information [3, 14].

In a study to compare student learning outcomes from computer- based instruction with a conventional dissection, the computer-based students had higher marks which were consistent across all grades of students. Possible reasons for the increase in marks was the flexibility of time using the computer-based instruction, the ability to see all structures clearly and the absence of smell and blood [14, 15]. However, there are dearth of videos and pictures with high resolution and audio-visual quality. In this exercise, we aimed to provide simulations containing step wise guideline on how we dissected and identified various regions of the rat anatomy. This could offer a viable alternative to the use of animals in biology classrooms and researchers alike who are dissecting the rat specie for the first time. It is important to state that this report is a first of its kind.

MATERIALS AND METHODS

Materials

Digital Camera (NUMY3GAX9 version), Happy Camper 12 LED and UCO Arka Rechargeable lights, 21G needle mounted on a 5 mL syringe, Forceps, Dissecting board, White plain sheets, Scissors, Pins, wools, Tris buffer solution (pH 7.5) and Chloroform. **(**Fig. 1 and 2)

Animals

Five (5) adult male Wistar rat (14-17 weeks old) weighing 235g-250 g were used for this exercise (Fig. 3). The animals were housed in well ventilated wire-wooden cages in the Animal Facility and an ethical clearance certificate with reference number NNHREC/05/01/2008b-FWA00002458-1RB00002323 was obtained from the University of Nigeria Health Research and Ethics committee. The animals were maintained under standard natural photoperiodic condition and allowed unrestricted access to water and rat chow. They were allowed to acclimatize for a while before the commencement of the exercise. Experimental procedures involving the animals and their care was conducted in conformity with International, National and institutional guidelines for the care of laboratory animals in Biomedical Research and Use of Laboratory Animals in Biomedical Research (CCAC, 1985) [16]. The guiding principles for research involving animals as recommended by the Declaration of Helsinki and the Guiding Principles in the Care and Use of Animals **(**American Physiological Society, 2002**)** [17] were adhered to.

Clarity of Audio-visuals

To ensure clarity of the pictures and videos, the illumination sources were placed 10 inches away from each. To ensure direct illumination, the light sources were placed directly on the structures to be visualized [18]. We achieved light reflection by making use of a white plain sheet of paper (Fig. 4 and 5).

PROCEDURE

External Anatomy

The first step was to anesthetize the rat by placing them in a closed jar containing cotton wool soaked in chloroform [19]. After few minutes, the knocked out rat was pinned to the board with the anatomical regions outlined (Fig. 5). The rat's body is divided into six anatomical regions:

1. Cranial region – head
2. Cervical region – neck
3. Pectoral region – area where front legs are attached
4. Thoracic region – chest area
5. Abdomen – belly
6. Pelvic region – area where the back legs attach

An incision was made with a scissors on the anterior abdominal wall towards the direction of the arrow as shown in figure 6. Then we cut slowly and carefully through the skin following the incision marks. We avoided cutting too deeply to prevent damaging the underlying structures by keeping the tip of the scissors pointed upwards (Fig. 7-9). Once the incisions were made, we pulled the skin away from incised midline and pinned the skin flaps to the side of the rat (Fig. 11-13). Another incision was made at the same point where the first one was made only this time we cut deeply into the muscle in other expose the organs (Fig. 14)

OUTCOME

Cervical/ Neck region

Trachea and the esophagus

To visualize the trachea and the esophagus just dorsal to the trachea, we cut through the throat muscles on the ventral side. The esophagus is distinguished from the trachea by its lack of cartilage rings (Fig. 11).

Digastric Muscle

The V shaped digastric muscle follows the lower jaw line and functions to open the mouth.

Mylohyoid Muscle

This muscle runs at right angles to the longitudinal axis. The edge of the digastric muscle was raised gently on each side of the jaw in order to see the mylohyoid. It functions to raise the floor of the mouth (Fig. 11).

Sternohyoid Muscle

This muscle runs parallel to the longitudinal axis on either side of the midline. It pulls the hyoid towards the sternum (Fig. 11).

Masseter Muscle

This muscle also known as the "cheek" muscle, functions in mastication (Fig. 11).

Pectoralis Major Muscle

This is a large triangular muscle covering the upper thorax. It functions to pull the arm towards the chest. Other structures such as the lacrimal gland, thymus and lymph nodes were also outlined (Fig. 11).

Thoracic Region

To see the organs of the thoracic and abdominal cavities, we cut through the ribs in the thoracic cavity and continue up to the throat region. We encountered the diaphragm and cut it away from the body wall. At the posterior end of the abdominal cavity, we cut laterally through the external oblique until we pin back the ventral side muscles and expose the organs underneath. We made another pair of lateral cuts toward the anterior end. However, we ensured not to cut through any organs to avoid a messy dissection.

In the thoracic cavity we noted the heart, ascending aorta and pulmonary vessels and some of the coronary arteries. We also outlined the lungs. We traced the trachea as it divides and goes into the lungs. There was a thymus gland covering the anterior half of the heart (This might not be the case in older rats).

Fig 1: Materials used for dissection

Fig 2: Illumination sources

Fig 3: Albino rats

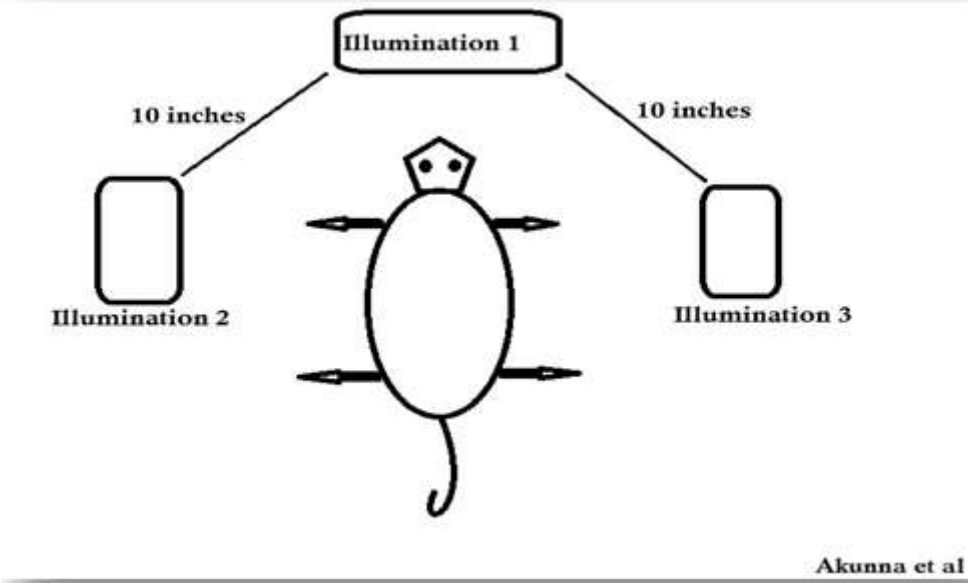

Fig 4: Illumination sources and arrangements

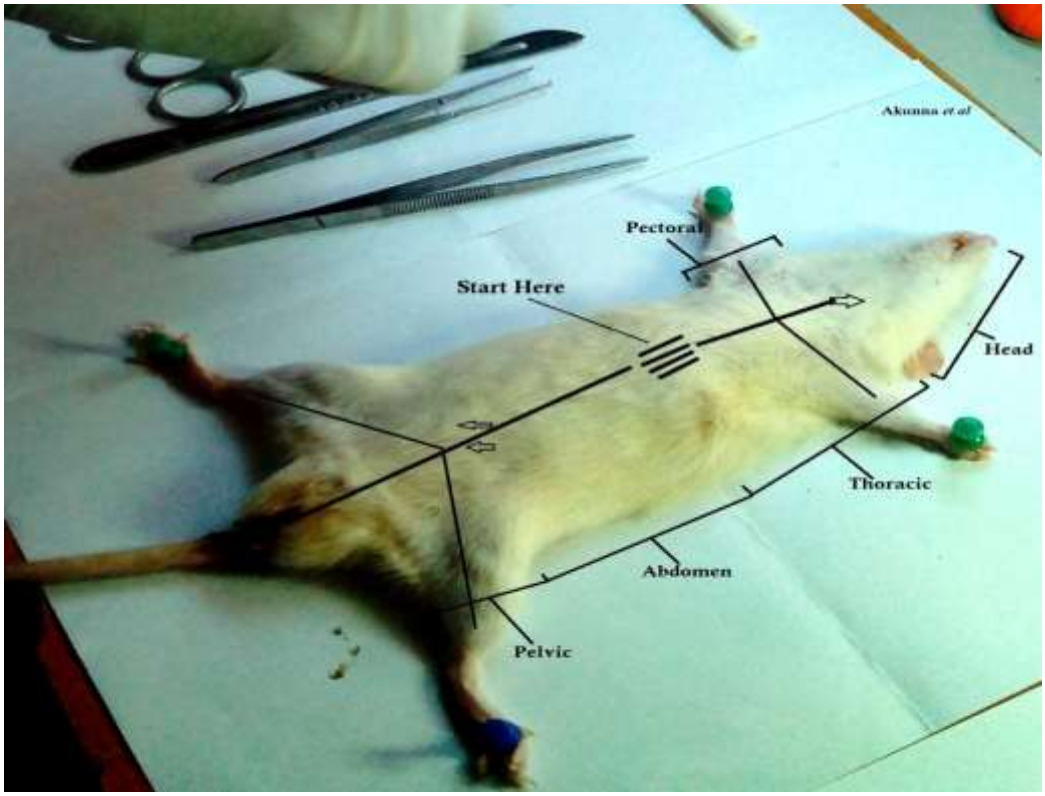

Fig 5: Anatomical regions

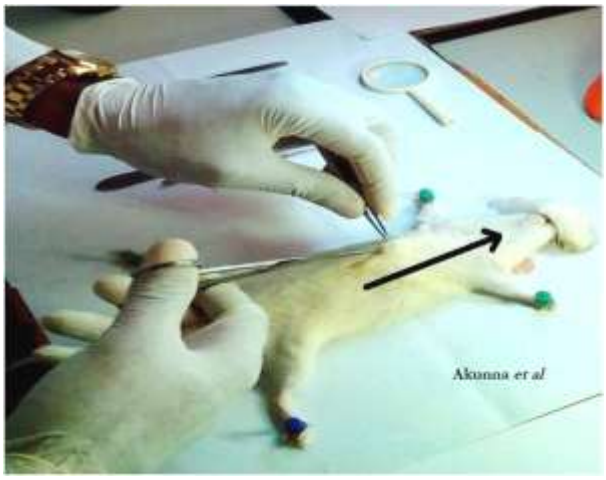

Fig 6: Making an incision towards the thorax

Figure 7: Extending incision to the head

Fig 8: Extending incision to the head

Fig 9: Making an incision towards the pelvis

Fig 10: Making incision towards the forearm

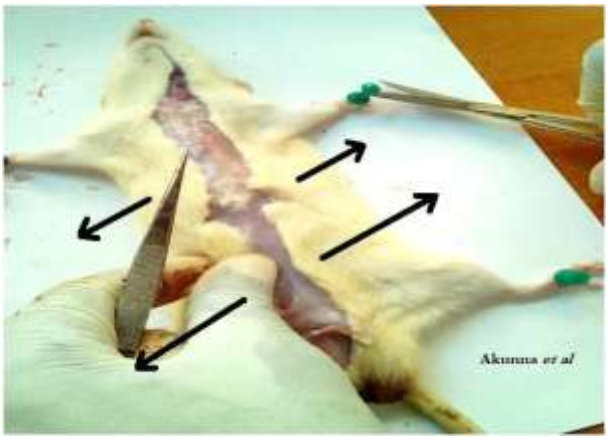

Fig 11: Pulling skin in opposite direction

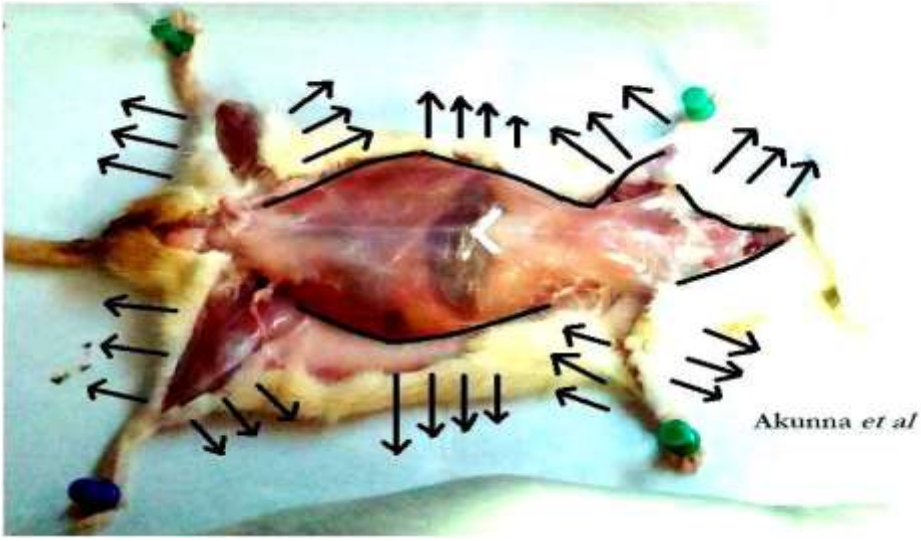

Fig 12: Skin pulled in different direction after incision

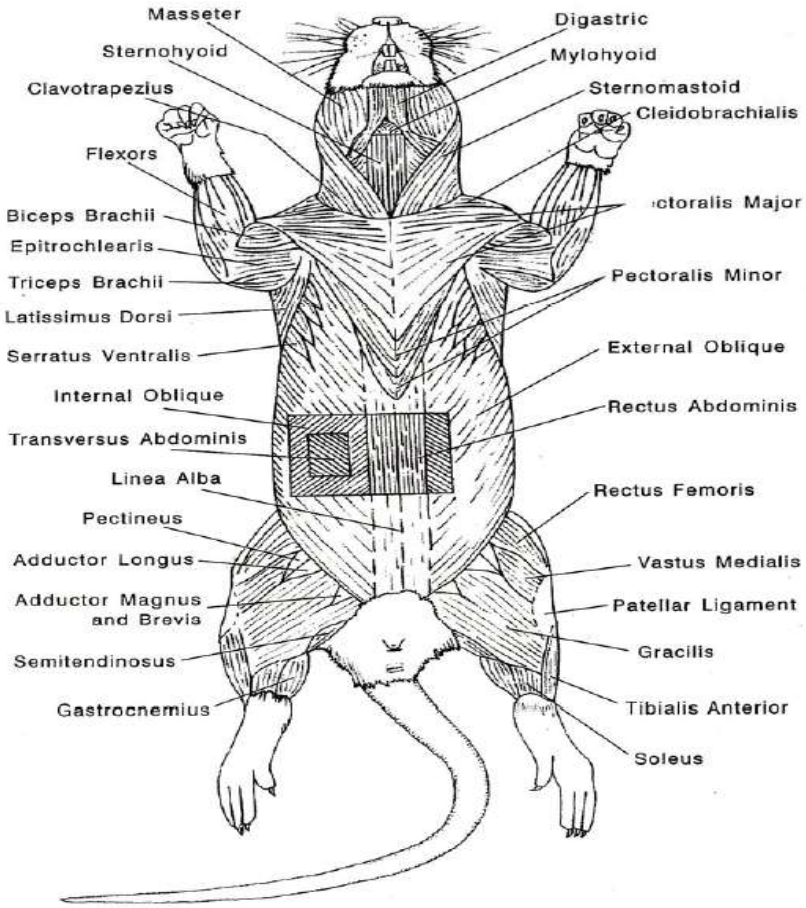

Fig 13: Muscles of the ventral surface

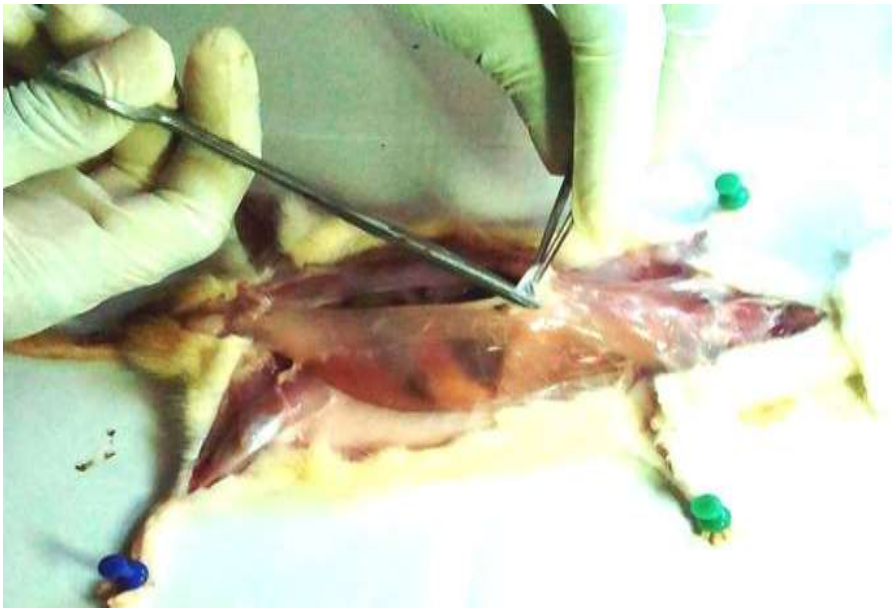

Fig 14: Incision on the ventral muscle to expose the internal organs

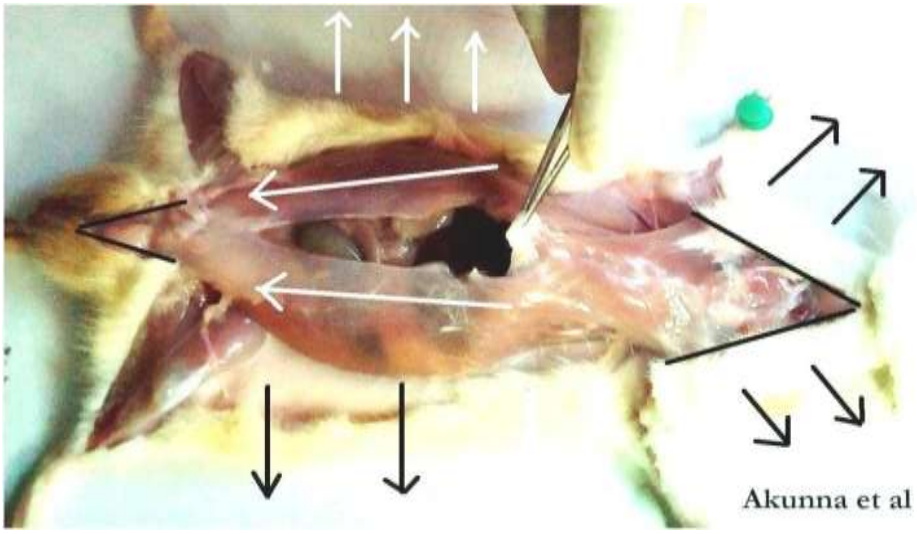

Fig 15: Incision devoid of blood stains

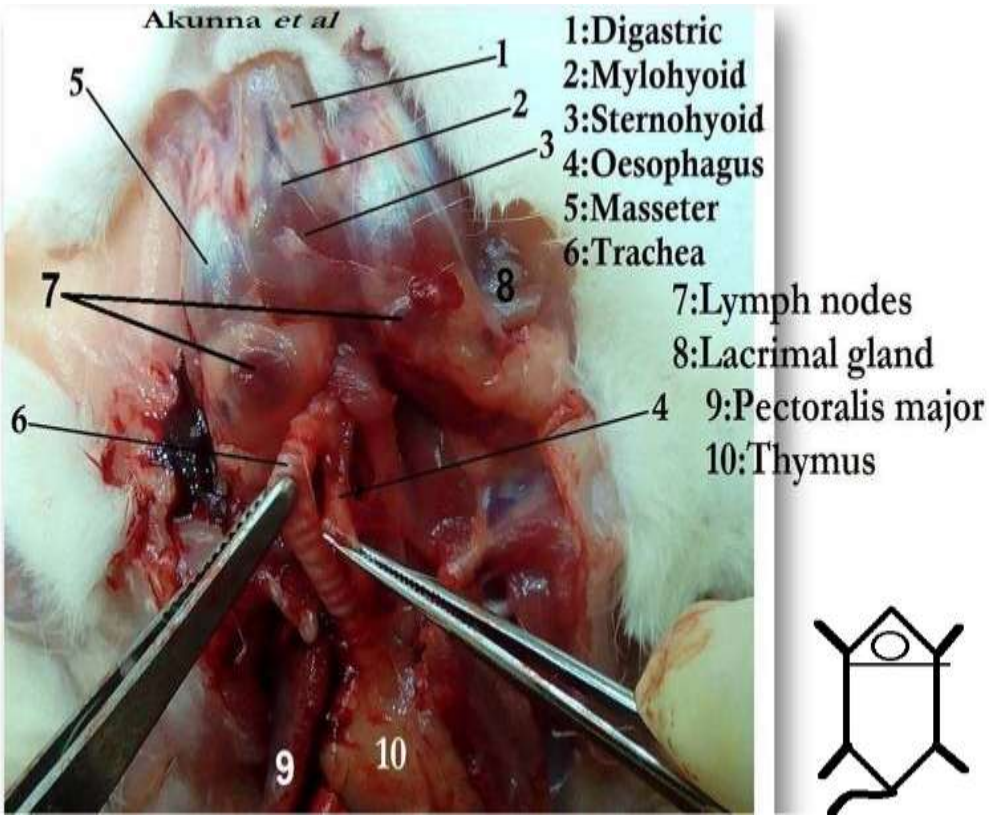

Fig 16: The cranial/cervical

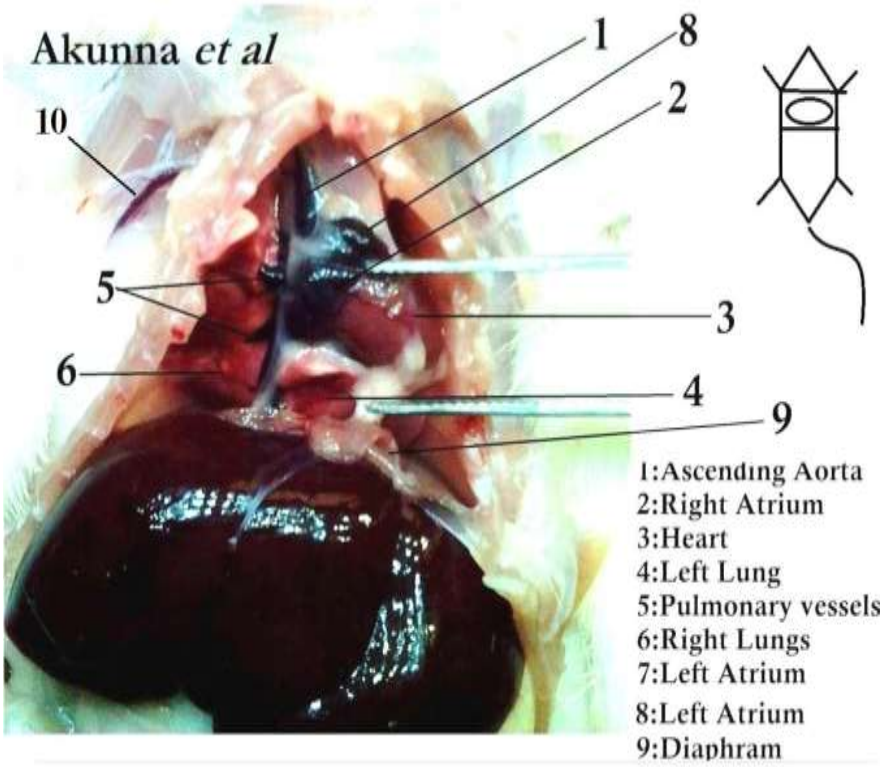

Fig 17: The thoracic region

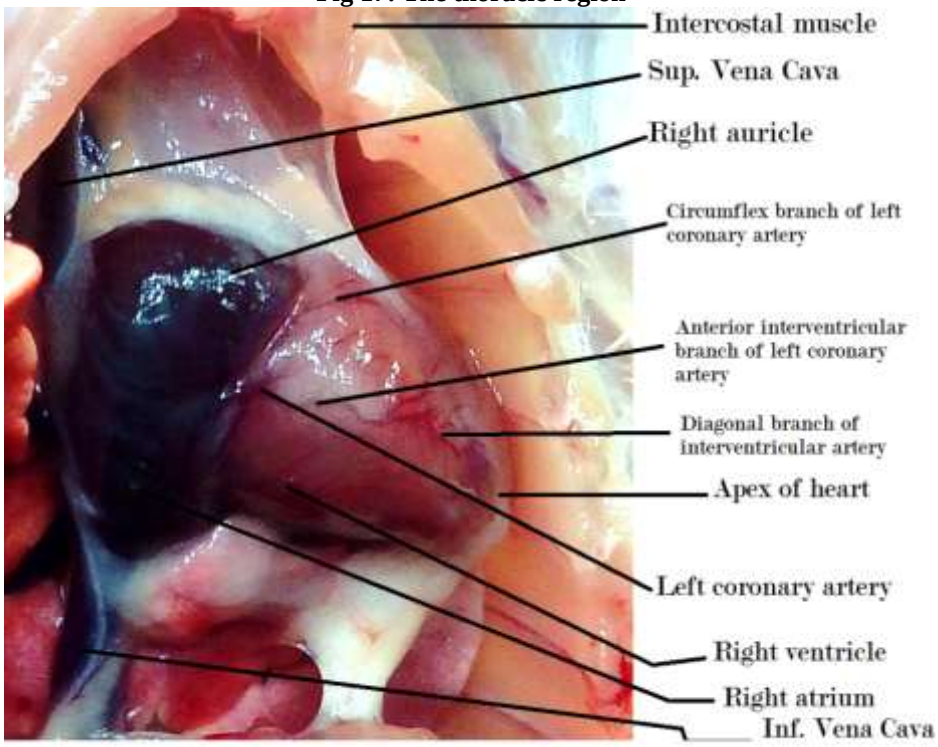

Fig 18: Coronary arteries

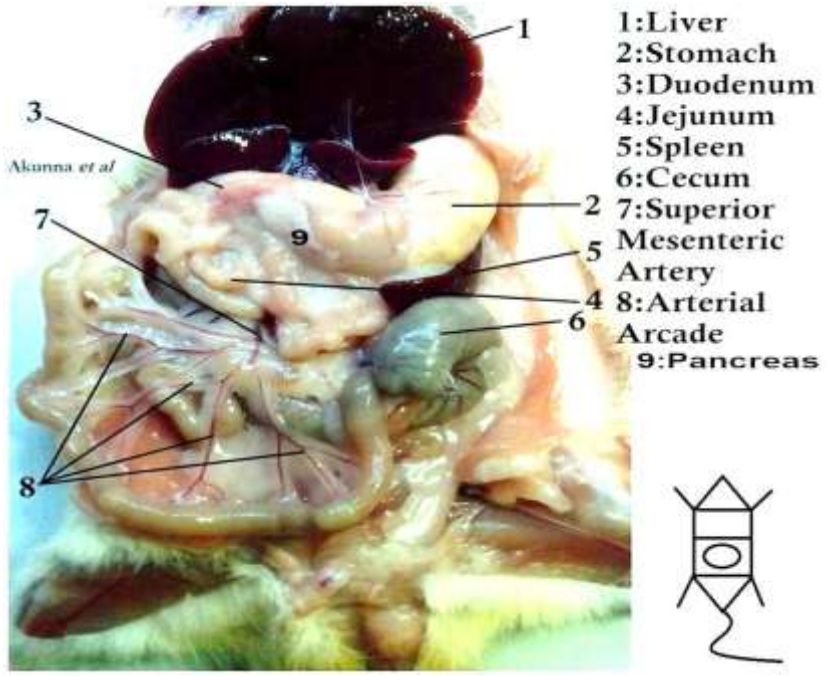

Fig 19: Abdominal region

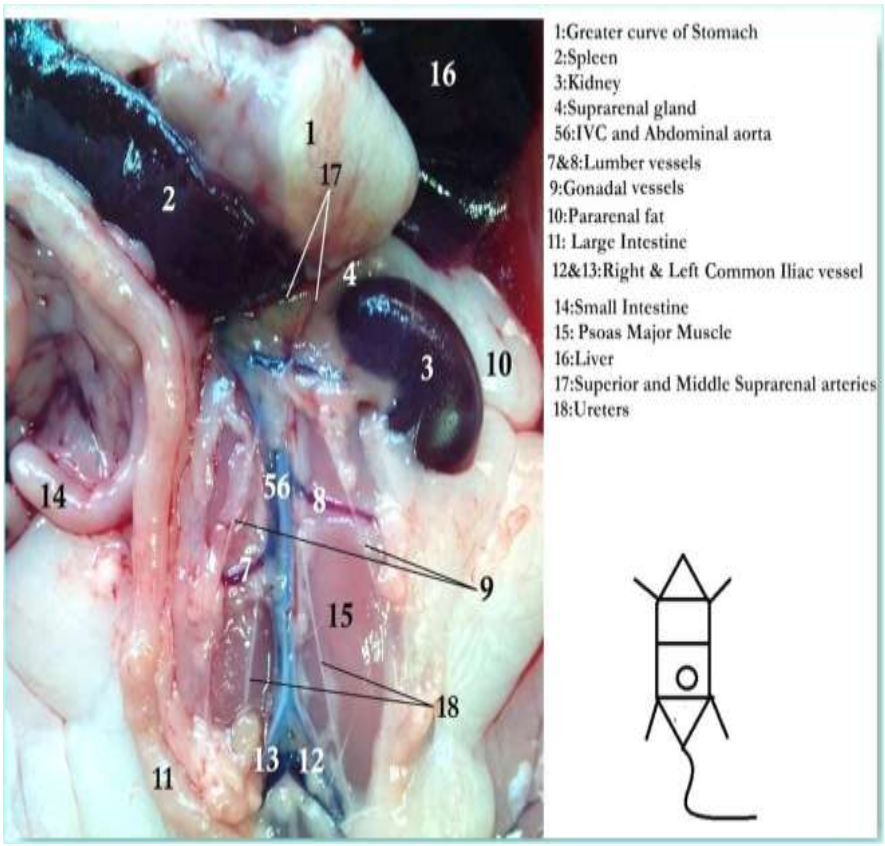

Fig 20: Posterior abdominal region

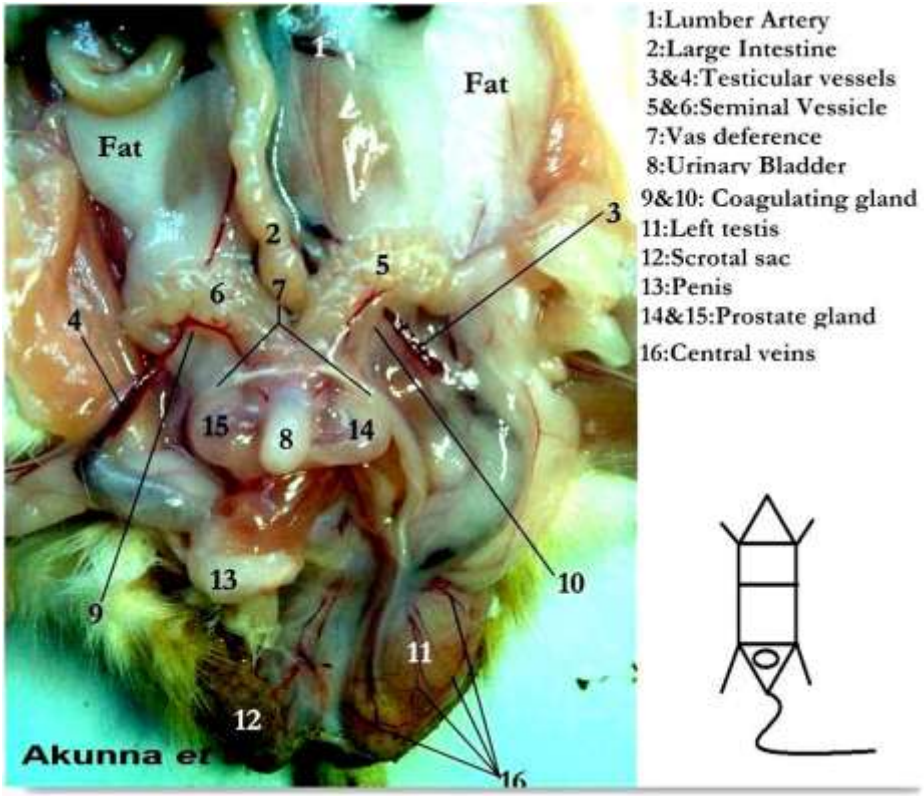

Fig 21: Pelvic/abdominal region

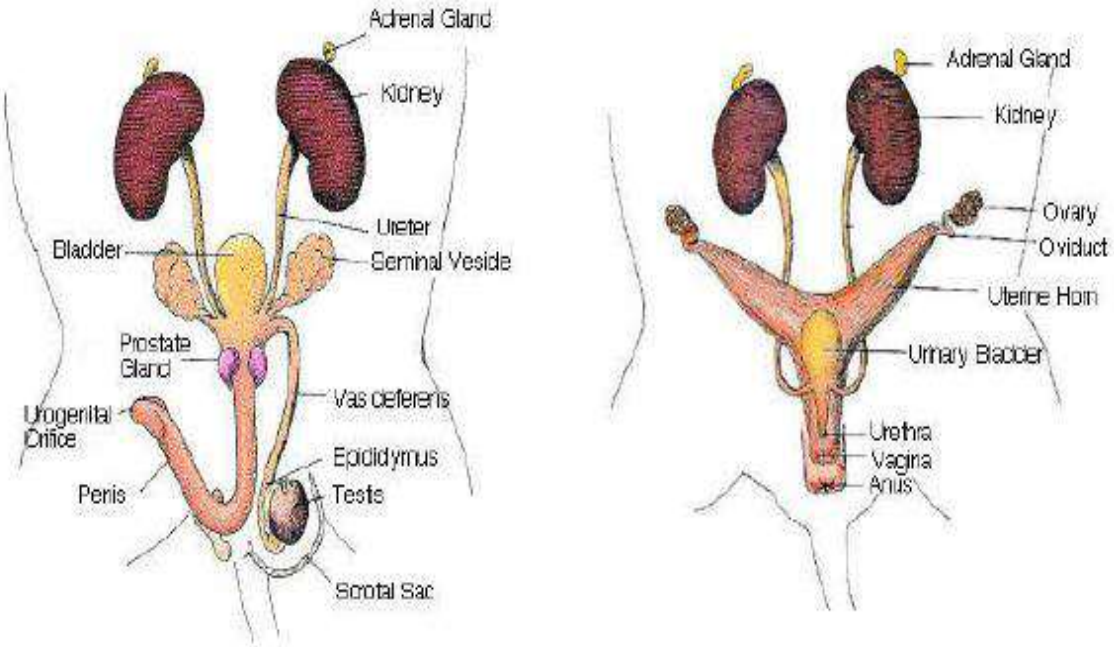

Fig 22: Urogenital system of male and female rat (Monika, 2013)

Abdominal Region

In the abdominal cavity, we pick up the esophagus as it comes through the diaphragm and noted where it enters the stomach. At the posterior end of the stomach there is a muscular valve called the pyloric sphincter that leads into the small intestine which is attached attached to the dorsal wall of the body cavity by mesenteries. The superior mesenteric arteries and its arterial arcade around the small intestine were also noted. The conspicuous liver lies over the stomach. It was noted that the rat has no gallbladder (Although most mammals does have one close to the liver. The flattened and reddish spleen was found lying just to the left and posterior to the stomach. We also outlined the diffused pancreases in the mesentery stretching along the stomach, spleen and small intestine. We follow the small intestine all the way to the large intestine. The blind-pouched caecum was located between the small and large intestines. We were very careful not to tear the mesenteries as we examine the intestines. The expanded rectum which opens to the anus was located at the end of the large intestine.

Uro-genital region

To visualize this region, we moved the intestines to one side. The two kidneys imbedded in the dorsal body wall were observed. The small ureters (often difficult to find) from the kidneys lead to the urinary bladder which empties to the outside through the urethra. The renal arteries, abdominal aorta were also outlined.

The scrotum was cut longitudinally through to locate the testes and continuously into the abdominal cavity. The epididymis lying around each testis was outlined. The vas deferens that leads from each testis to the urethra was also outlined. To either side of the bladder are two sets of glands. A smaller, round, more posterior ones, the prostate glands and a larger pair of glands, the seminal vesicles, which are actually two different glands-the vesicular glands and the coagulating glands. The urethra was traced as it goes through the penis.

The video modules of rat dissection are available on you tube platform with the following link. It must be stated that the views has rising to two hundred and eight views at the time of writing this article.

1. https://youtu.be/QD8uwDEIBwU
2. https://youtu.be/kIWp8ZhnJ9k
3. https://youtu.be/sUtuRN_5p58
4. https://youtu.be/d1PSuMAcDYg

Limitations

Because this exercise was part of a larger research focusing on male rats, we were not able to provide a guide for the female rat. However, it should be noted that the anatomical similarities are striking except for the urogenital region. The reproductive system of female rats is comparatively simple.

Theprominent uterine horns pass dorsally to the bladder and ureters. The vagina is located where the horns join dorsal to the urethra and opens to the exterior through the vaginal opening which is ventral to the anus. The anus is in turn ventral to the tail while the urethral opening is ventral to the vagina. At the anterior end of each uterine horn is a short, convoluted oviduct that opens into a round ovary.

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