Résumé Avicenne (également connu sous le nom d'Ibn Sina, de 980 à 1037 après. J.-C) était le médecin et savant perse le plus érudit de l'époque médiévale (9e—12e siècle de notre ère). Avicenne a contribué à divers domaines de la médecine, de l'astronomie et de la métaphysique de son siècle. Dans le domaine des sciences médicales de base, Avicenne a systématiquement décrit l'anatomie, la pathologie et les troubles liés à de divers organes du corps humain et mis au point des interventions chirurgicales visant à les traiter. Avicenne a compilé son célèbre livre, Le Canon de la Médecine, qui est devenu le manuel de référence sur la médecine, dans la région et dans l'ouest. Bien qu'aucune dissection cadavérique humaine ou formation chirurgicale n'ait été officiellement transcrites à son époque, les informations anatomiques et chirurgicales présentées dans le Canon de la Médecine sont comparables aux écrits de la littérature moderne. Dans le traité actuel, nous présentons une analyse de l'anatomie topographique de base et fonctionnelle des systèmes reproducteur et uro-génital, ainsi que certains concepts de procréation présentés dans le Canon de Médecine, en les comparant à ceux de la littérature médicale moderne. Nous avons estimé que les informations d'Avicenne sur ces systèmes étaient cohérentes avec celles trouvées dans la littérature actuelle. Les seules différences sont attribuables aux contrastes entre les approches expérimentales, celles d'Avicenne étant dérivées d'une époque définie par des développements technologiques moindres, notamment concernant l'histologie des organes. Cependant, les informations d'Avicenne dans ce traité peuvent être considérées comme innovatrices dans les domaines de l'urologie et de la gynécologie.

Introduction

Ibn Sina (Avicenna in the West), was a Persian Muslim scientist and one of the greatest physicians and philosophers in the medieval era (Fig. 1) [1—3]. He was born in 980 AD in old Persia in Boukhara (in present-day Uzbekistan) and died and buried in 1037 AD in Hamedan, Iran [4—6]. Avicenna became famous through his medical textbook the Canon of Medicine [7]. The textbook was adopted as the main referral book in Western and Arabic universities for centuries [1,7]. The medical principles presented in the Canon of Medicine were based on traditional Greek (Unani), Roman and Chinese medicine [5]. Avicenna emphasised on integrative, holistic treatment and examination approaches to his patients [8,9]. In addition, he emphasised on the importance of the subject of anatomy and regarded it as being pivotal to the practise of medicine [1,10]. To support the importance of anatomy in medical practise, Avicenna in his book the Canon of medicine devoted the early chapters of the book to anatomy of the human body and also the anatomy of the various regions was described at the beginning of each section on any disease condition, particularly information related to that disease [11]. To date numerous research articles analysing the Avicenna's anatomical concepts in the Canon of Medicine have been and continues to be published. Although there is lack of conclusive evidence on the source of his anatomical information since there is no record of formal human cadaver dissection training in his treaties. Some evidence suggests that Avicenna acquired his information from animal cadaver dissection and vivisection on live animals [1].

Avicenna's information on the genital and urinary organs, although it was presented about 1000 years ago still compares with modern information in anatomy and associated literature. Avicenna described the anatomy and pathology of the urinary tract and reproductive system in both males and females. In other discoveries and advances related to the genitourinary systems, he advised on urine analysis in

Figure 1 Drawing of Ibn Sina on a Polish postage stamp. Image obtained from the Muslim Heritage site http://www.muslimheritage.com/article/ibn-sinas-canon-medicine. Downloaded 20th of March 2018.

health and disease, whereby he suggested the timing of urine collection and the urine characteristics such as colour, turbidity, consistency, odour, sediments, volume and foaminess [4,11—14]. Avicenna expounded on obstructive diseases of the urinary tract and suggested on herbal and surgical

treatment of these disorders [13]. He mentioned the use of grasping forceps and mechanical litholopaxy in the managements of urinary bladder stones [15]. He characterized the pain from kidney and urinary bladder stones and suggested that the former was more painful than the latter [11,16]. Avicenna cautioned on the importance of the knowledge of anatomy in conducting cystolithotomy thereby minimizing the risks of sterilising the patient [11,12,14,16]. Herein, we analysed the functional anatomy of the genitourinary and reproductive systems as viewed by Avicenna in the Canon of Medicine textbook and compared their relevance to modern anatomy and physiology literature, particularly to the extant textbooks used in medical schools.

The kidney (pages 1061 — 1062)

The descriptions of the anatomy and functional correlates of the kidney were derived from the Galenic (200 AD) principles where Avicenna erroneously described the right kidney as located at a plane higher than the left kidney. This description originated from the misconception that there was a communication channel between the liver and the right kidney. Avicenna stated that:

> ''The right kidney is located above the left one in order to be closer to the liver. It receives more matter from the liver. The right kidney has a direct connection with the liver and it attaches to the livers accessory part that is on its side'' [16].

The left kidney was described as occupying a lower position to the right kidney because of its relationship to the spleen and hence it was pressed down by it [11,12,16]. Instead, modern anatomy literature shows that the right kidney is located below the liver at a lower level than the left kidney [17]. With regards to the position and relationship of the left kidney and the spleen, Avicenna stated:

> ''The left kidney is located lower and there are two reasons for this: The left kidneys might make trouble for the spleen...'' [16].

Avicenna mentioned that the kidneys were designed for the excretion of excess water and waste substances from the blood. He also deliberated on the compensatory mechanisms of having two kidneys in case one fails due to disease [11,16,18]. The compensatory mechanism in kidney function was further developed to allow for kidney transplantation and donation, a technique, which was first implemented by surgeon Yurii Voronoy (1895—1961) in the year 1933 [19]. On the functions and number of kidneys, Avicenna stated that:

> ''Now we can say in the description of the kidney that the kidney sends that watery matter out of the body. Since this watery matter is a great amount, the organ that sends it out needs to be large enough to hold it, or else there should be a pair of these organs. If there were just one large one, it might at some point become narrowed and if there were too much water, this would cause difficulties. This is why God made the kidneys in a pair, and there are some benefits in this...'' [16].

Avicenna described the origin and course of renal vessels and their relationship to gonadal vessels [11,12,16], but did not clearly expound on their respective. He assumed that both renal arteries and veins bring blood and nutrition respectively to the kidney [11,12,16]. Avicenna described the renal pelvis within the kidney; how it fills with urine and the subsequent transport of urine to the urinary bladder through the ureters. Avicenna stated that:

> ''There are spaces inside each of the kidneys to which the watery matter drops from a short canal or duct. It goes from those spaces to the bladder through another canal or duct. The carrier canal to the bladder receives the water little by little and sends it to the bladder'' [16].

He also acknowledged the role played by the kidney in the filtration of blood and slowly releasing the excess water as urine into the bladder. He described the filtration process and excretion of urine as a very slow process. He stated that:

> ''Why does the water go little by little from the kidney to the bladder? Because the water that comes to the kidneys directly has not been completely refined. It still has a part of the bloody matter (sanguinous humour) with it. The kidney has to filter this water mixed with blood and feed from the blood that it receives from this water. It then sends the extra refined water—that is completely separated from the blood—towards the bladder...'' [16].

He also described the innervation of the kidney through sensory nerves found in the covering capsule and devoid in the kidney parenchyma.

> ''There is a small nerve in the kidney from which the kidneys covering is made'' [16].

Urinary Bladder (pages 1109 — 1110)

Avicenna described the function of the urinary bladder based on a two phase dogma which still stands in modern physiology principles. According to Yoshimura [20] the urinary bladder functions in two separate phases: first the storage phase whereby the urinary bladder fills with urine and second the voiding or emptying phase whereby urine is excreted to the external environment. Avicenna stated that:

> ''...Also, God made a small reservoir-like thing for waste and useless water, so that it accumulates there little by little and all comes out at the proper time. The person does not need to urinate every minute and hour like a strangury patient.'' [16].

Avicenna described the bladder wall as made up of elastic tissue and tendons because of its capacity to expand in volume and diameter during filling. He stated that:

> ''It is made from tendons, and there are two reasons for this: 1. To make it as tight and hard as possible to avoid rupture. 2. To make it elastic so that it can be extended and filled with water while remaining stable'' [16].

Instead, modern histology literature describes the muscular wall of the urinary bladder as consisting of smooth muscle tissue which is distensible on filling and contracts during emptying [21]. In addition, he described the urinary bladder wall as having only two layers.