RESEARCH ARTICLE

Volumetric analysis of the total and subcomponents of the chinchilla kidneys

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Özet

Başaran E, Akosman MS, Çevik Demirkan A. Şinşilla böbreğinin total ve alt bileşenlerinin hacim analizi. **Eurasian J Vet Sci, 2013, 29, 4, 171-175**

Amaç: Böbreklerin ve alt bileşen hacimlerinin bilinmesi tedavide ya da gerçekleştirilecek olan çalışmalarda göz önünde bulundurulması gereken kritik önemi olan bölgelerdir. Sunulan bu çalışma beş adet erkek ve beş adet dişi yetişkin şinşillanın sağ ve sol böbrekleri üzerinde gerçekleştirilmiş olup böbreklerin total ve alt bileşenlerinin hacimlerinin hesaplanması amaçlanmıştır.

Gereç ve Yöntem: Çalışmada beş adet dişi ve beş adet erkek yetişkin şinşillanın sağ ve sol böbreklerinin toplam ve alt bileşenlerinin hacimleri hesaplandı. Arşimet prensibi sadece toplam hacim ölçümünde kullanılırken Cavalieri metodu böbreklerin hem toplam hem de alt bileşenlerinin hacim hesaplanmasında kullanıldı.

Bulgular: Analizler sonucunda ortalama böbrek hacimleri Arşimet prensibine göre erkekler için 1.11 cm^3 iken dişiler için 0.94 cm^3 olarak bulundu. Cavalieri metoduna göreyse bu değer erkekler için 0.97 cm^3 iken dişiler içinse 0.84 cm^3 olarak hesaplandı. Korteks, medulla ve pelvisin yüzde oranları da erkekler için %71, %26, %3 ve dişiler içinde %71, %27, %2 olarak bulundu. Metotlar ve cinsler arasında, cinsler içinde ve böbrekler arasında istatistiksel olarak karşılaştırma yapıldığında herhangi bir önem ($p>0.05$) bulunamadı.

Öneri: Böbreğin toplam hacmi hem Arşimet prensibi hem de Cavalieri metoduyla ölçülebilir. Ancak böbreğin alt bileşenleri sadece Cavalieri metoduyla hesaplanabilir. Sunulan bu çalışmada şinşilla böbreğinin toplam ve alt bileşenlerinin hacimleri morfolojik olarak ortaya konmuştur. Böbrek üzerinde yapılacak olan deneysel çalışmalarda bu bölgelerin hacimlerinin ölçülmesi çalışmaya katkı sağlayacaktır.

Anahtar kelimeler: Böbrek, şinşilla, Cavalieri metodu, böbrek alt bileşenleri, hacim

Abstract

Basaran E, Akosman MS, Cevik Demirkan A. Volumetric analysis of the total and subcomponents of the chinchilla kidneys. **Eurasian J Vet Sci, 2013, 29, 4, 171-175**

Aim: It is critically important to know the volume of the kidneys, which are vital for the body, in order to use the volume data for the treatment or to contribute to other studies. Thus present study aimed to estimate the total and subcomponent volume of the kidney in the chinchilla.

Materials and Methods: The present study was estimated the total and subcomponents volume of left and right kidneys of five male and five female adult chinchillas. The kidneys' total volume was measured by both Archimedean Principle and Cavalieri method while the volumes of the subcomponents were estimated by Cavalieri method. All estimated parameters were compared by statistically.

Results: The mean volume of the kidneys' was estimated as 1.11 cm^3 for males and 0.94 cm^3 for females by Archimedean principle. However it was 0.97 cm^3 for males and 0.84 cm^3 for females by Cavalieri method. The volume fractions of the kidney cortex, medulla and pelvis were 71%, 26%, 3% for the male and 71%, 27%, 2% for the female, respectively. Moreover all parameters such as weight, volume and volume fractions were statistically evaluated and no significant difference ($p>0.05$) was observed between the right and left kidneys and between the genders.

Conclusion: The total volume of the kidney could be estimated by both Archimadean principle and Cavalieri method. However, the volume of the subcomponents in the kidney could only be estimated by Cavalieri method. Actually, total and subcomponent volume estimations of the kidney will contribute the findings of the experimental studies. It was concluded that this stereological study could provide a valuable contribution to future studies performed on kidney.

Keywords: Kidney, Cavalieri method, chinchilla, kidney subcomponents, volume

Introduction

Chinchilla is a rodent and the member of the Chinchillidae family (Erencin 1977, Kurschner 1992). Recently, chinchilla modeling is frequently used in several studies (Giebink 1999, Bakaletz 2009). The response of the chinchilla kidney against some chemicals was investigated in the toxicological and pharmacological comparative experiments and generally evaluated histopathologically (Klimtova et al 2002, Ewuola 2009). Additionally to the histopathological examination, total and the subcomponents (cortex, medulla, and pelvis) volume estimation of the kidney may also be beneficial. Because, the total and the subcomponent volume estimation of the kidney has been suggested as an index for studying the health status of the kidney (Adibi et al 2008). The renal mass and the morphological changes is an indicator of the renal functional reserve (Coulam et al 2002, Bailey et al 2004, Michael et al 2007). Thus, the volumetric measurements on the kidney may produce valuable data of the organs' status (Coulam et al 2002, Adibi et al 2008, Pazvant et al 2009).

The volume estimation of the renal parenchyma could easily be achieved by Cavalieri method (Gundersen et al 1988, Nyengaard 1999, Pereira-Sampaio et al 2008, Pazvant et al 2009, Bolat et al 2011, Lenger and Akosman 2013). It presents simple and efficient estimates related with the object (Gundersen et al 1988, Agashiwala et al 2008). This method initially starts by a random cut through the tissue following subsequent cuts at regular intervals. Thus systematic and random sections provided. The volume of the tissue obtained by multiplying the sum of the profile areas of the tissue on all sections by the distance between them (Gundersen et al 1988, Schmitz and Hof 2007). The profile areas of the tissues on sections could be estimated by the transparent test probe superposed. The transparent test probe consists of the regularly spaced points in a known distance. The area fraction of the profile is determined by counting all points hitting on the profile (Gundersen et al 1988). This method was once applied successfully on the pig, sheep, rabbit, horse and cattle, kidneys (Pereira-Sampaio et al 2008, Pazvant et al 2009, Bolat et al 2011, Bolat et al 2013, Lenger and Akosman 2013). Thus, we decided to perform Cavalieri method on the chinchilla kidney and estimate its total and subcomponents' volume and contribute to the literature.

Materials and Methods

The study was performed on five male (550-600 g) and five female (500-550 g) adult chinchillas' (Chinchilla lanigera) kidney. The chinchillas obtained from the project (06. VF.20) supported by Scientific Projects Coordination Center of Afyon Kocatepe University and study was achieved by authorisation of Research Animals Ethics Commission of the Afyon Kocatepe University (Akuhadyek-Reference Number-14/06).

The neutral buffered 10% formalin solution for fixation applied under general anesthesia to whole subjects from the jugular vein and fixation continued in the container filled by the same solution. After fixation, the kidneys on both sides were extirpated, and weighed. Briefly, the total volume of the whole kidney was measured by Archimedean principle depends on the water overflow from the graded cylinder. For the Cavalieri method, the kidney was sliced into 0.1 cm intervals with a random start (Figure 1). Depending on kidney size nearly twenty sections were obtained for the volume estimation per kidney. The volume of the total kidney and its subcomponents were measured individually. The profile areas of the slices measured by transparent test probe superposed consist of 0.25 cm regularly spaced points. The 0.25 cm regularly spaced point probe was used for the estimation of the total kidney, cortex, medulla, and pelvis volume. For this process, sum of the points hitting to the cortex, medulla and pelvis first individually than for the total volume totally evaluated and calculated by the following formula;

$$V = (t \cdot a/p \cdot \sum P)\ cm^3$$

t : section thickness (0.1 cm),
a/p : the area represented by a point in the grid (0.25 cm x 0.25 cm),
$\sum P$: Total number of points hitting the surface area of the sections.

The coefficient of error (CE) of the study was calculated according to Nyengaard (1999).

Figure 1. The sliced chinchilla kidney according to Cavalieri method.

The weight and the estimated kidney volume evaluated by Mann-Whitney U test and the comparison of the Archimedean principle and the Cavalieri method evaluated by one sampled t test (SPSS 17.0). The significance level was set at $p<0.05$.

Results

Macroanatomical results

All chinchillas in this study were clinically healthy. The mean kidney weight was 1.74±0.3 g for the male and 1.70±0.2 g for the female. The weight differences between and in the genders for the kidney placed on the right side and the left side were not (p>0.05) statistically significant.

Methodological comparison

The mean kidney volume estimated by Archimedian principle was 1.11±0.4 cm^3 for the male and 0.94±0.4 cm^3 for the female. The mean kidney volume estimated by Cavalieri method was 0.97±0.3 cm^3 for the male and 0.84±0.3 g for the female (Table 1). The comparison of results between these two methods was not (p>0.05) statistically significant.

Volumetric evaluation

According to the findings of the Cavalieri method, the volume differences between and in the genders for the kidney placed on the right side and the left side did not (p>0.05) statistically significant (Table 1). The coefficient of error (CE) of the Cavalieri method was calculated as 0.03.

Volume fraction of kidney components

The volume fractions of the kidney according to Cavalieri method of the cortex, medulla and pelvis were 71%, 26%, 3% for the male and 71%, 27%, 2% for the female, respectively. The volume differences between and in the genders for the kidney placed on the right side and the left side were not (p>0.05) statistically significant.

Discussion

In this study the renal parameters of the adult male and female chinchilla investigated macroscopically. The estimation of the total volume and the volume fractions of the kidney are essentially important in the determination of the creatinine clearance and thus indicate the potential functional capacity of the kidney (Pereira-Sampaio et al 2008). The total volume of the kidney previously estimated in the Sprague Dawley rats by Cavalieri method was 1.7 cm^3 (Altunkaynak et al 2008). The total kidney volume was measured as 0.72 cm^3 and 0.82 cm^3 in the 9 and 14 weeks old Sprague Dawley rats, respectively (Nath and Salahudeen 1990). According to previous reports the four weeks old Wistar-Kyoto offsprings' had 0.28 cm^3 (Zimanyi et al 2000) and ten weeks old Wistar-Kyoto's had 1.2 cm^3 total kidney volume (Kett et al 1995). The volume of the kidney subcomponents generally concentrated on the pharmacological (Kett et al 1995), comparative (Pazvant et al 2009, Simsek et al 2009, Bolat et al 2011, Bolat et al 2013, Lenger and Akosman 2013), and nutritional aspects (Altunkaynak et al 2008). In fact, approaching to the volume fraction is a big advantage than the total volume (Pazvant et al 2009). Recently, scientists revealed the subcomponents volume and thus volume fractions of the kidney. The horses' left kidney consists of 57% cortex, 41% medulla and 2% pelvis and right kidney consists of 54% cortex, 44% medulla, 2% pelvis (Bolat et al 2013). The mean cortex and medulla volume fraction of the cattle kidney is 69% and 31%, respectively (Lenger and Akosman 2013). The volume fractions of cortex, medulla and pelvis were 69.2%, 27.7%, and 3.1% for the female ram respectively, and 70.2%, 26.4% and 3.4%, for the male ram, respectively (Pazvant et al 2009).The rabbits' left kidney consists of 59.7% cortex, 36.4% medulla, 3.8% pelvis and right kidney consists of 61.8% cortex, 34.7% medulla, 3.4% pelvis (Bolat et al 2011). The volume fraction of the cortex in foetal kidneys (86%) was higher than in newborn (54%) or adult rats (77%) (Simsek et al 2009). In the present study, the volume fractions of the kidney in the chinchilla consist of 71% cortex, 26% medulla, 3% pelvis for the male and 71% cortex, 27% medulla, 2% pelvis for the female.

In our study, no statistical significance (p>0.05) was detected between the Archimedean principle and the Cavalieri method (Table 1). The Archimedean principle allows rapid

Table 1. Weight and volume parameters of the chinchilla kidney.

Male					
Mean Kidney Weight		Mean Kidney Volume (Archimedean Principle)		Mean Kidney Volume (Cavalieri Method)	
Right	Left	Right	Left	Right	Left
1.77 g	1.71 g	1.10 cm^3	1.12 cm^3	0.96 cm^3	0.98 cm^3
Female					
Mean Kidney Weight		Mean Kidney Volume (Archimedean Principle)		Mean Kidney Volume (Cavalieri Method)	
Right	Left	Right	Left	Right	Left
1.80 g	1.58 g	1 cm^3	0.88 cm^3	0.9 cm^3	0.78 cm^3

There were no statistically significance between all estimated parameters (p>0.05).

estimations of the total organ but Cavalieri method estimates both total and the organ subcomponents volume (Akosman and Ozdemir 2010). The Cavalieri method works simply and produces efficient and current results (Gundersen et al 1988, Pazvant et al 2009). The volume estimation of the kidneys in vivo could be achieved by magnetic resonance imaging (MRI) (Coulam et al 2002) and in addition the Cavalieri method could able to combine with the MRI (Sonmez et al 2010). It has been reported that the MRI measurements of the total renal volume is accurate, however the fractional measurements are limited but promised yet (Coulam et al 2002). Moreover, by MRI, workers achieved to reach the total glomerular number and size in the kidney (Beeman et al 2011). Variations in the number and size of the glomeruli are also the indicator of many renal and systemic diseases (Beeman et al 2011).

Conclusions

In conclusion the total and the subcomponents volume of the chinchilla kidney were estimated in this research. This kind of estimation on the kidney especially important in the experimental and comparative studies. The volumetric quantities of the kidney were obtained by means of stereological methods in our study. The researchers believed that it would be beneficial if the volume of the total and the subcomponents of the kidney are analysed and the data generated here may contribute to the current knowledge.

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