



# Determination of Normal Mean Ejection Fraction Index by Echocardiography in *Oryctolagus Cuniculus*

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## Abstract

**Background and aim:** *Oryctolagus cuniculus* are an excellent model for cardiovascular research because the size of these animals is more suitable for study and experimentation than smaller animals and are economical and cost-effective in research. One of the most important diagnostic imaging techniques is echocardiography, which is used today to perform anatomical and functional evaluation of the cardiovascular system and is one of the most accurate and sensitive non-invasive methods for examining heart diseases. Ventricular function indices could be assessed by cardiac imaging techniques. One of these important cardiac parameters is the ejection fraction, which has a valuable position along with other involved parameters. Ejection fraction is a measure of blood percentage that comes out of the heart with each contraction.

**Materials and Methods:** For this study, 100 six-month to one-year adult, standard and young *Oryctolagus Cuniculus* (in Iran) and in healthy appearance of both sexes (50 female rabbits and 50 male rabbits) were studied without anesthesia and sedation.

**Results:** In this study, the mean ejection fraction in the studied *Oryctolagus Cuniculus* was  $58.753 \pm 6.889$  in male animals and  $61.397 \pm 6.530$  in females which indicates that the ejection fraction in the assessed male population was significantly higher than the female population.

**Conclusion:** The measured ejection fraction values were comparable to those mentioned in the authoritative books and there is no significant difference in the average size of ejection fraction measured in this study with the previous research.

**Keywords:** Echocardiography, *Oryctolagus cuniculus*, Ejection fraction, Heart

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## Introduction

*Oryctolagus cuniculus* are an excellent model for cardiovascular research because the size of these animals is more suitable for study and experimentation than smaller animals and are economical and cost-effective in research. The myocardium of *Oryctolagus cuniculus* is more similar to that of humans than that of dogs and cats. One of the most important diagnostic imaging techniques is ultrasonography, which is used today for anatomical and functional evaluation of the cardiovascular system. Echocardiography is one of the most accurate and sensitive non-invasive methods for examining heart diseases, but it is a costly method and is not available to all treatment centers (Fontes-Sousa *et al.*, 2006). Primary extensive echocardiographic research has previously been performed on populations of small animals without racial separation in relation to the determination of natural echocardiographic parameters, but over time and with the development of echocardiography in small animals, the effects of some factors such as weight, age and especially breed on some species of animals were studied and the results showed significant differences in some echocardiographic parameters in different breeds (Jacobs & Knight, 1985).

In the meantime, the existence of normal functional indicators in a particular breed, like *Oryctolagus cuniculus*, is necessary to be compared with what is mentioned in the reference books as well as reference values in the region to evaluate its morbid conditions. In our country, very little study has been conducted in this field and the need for more research is felt, especially in the *Oryctolagus Cuniculus* breed. Ventricular function indices can be assessed with cardiac imaging techniques. Among these important cardiac parameters, the ejection fraction could be mentioned, which has a valuable position along with other involved parameters (Slater & Herrtage, 1995).

Ejection fraction is a measure of blood percentage that comes out of the heart with each contraction. At each heartbeat, the heart contracts and dilates. When the heart contracts, blood is expelled from the two ventricles of the heart. As the heart dilates, the ventricles fill with blood again. But it must be mentioned that no matter how strong the contraction is, the ventricles will never be completely empty. The

term "ejection fraction" refers to the percentage of blood that comes out of a blood-filled ventricle with each heartbeat (Fontes-Sousa *et al.*, 2006). The left ventricle is the main pumping site of the heart, so usually only the left ventricular ejection fraction (LV) is measured. The ejection fraction is an ideal indicator of the strength of ventricular contraction and expresses the amount of blood drawn out after the diastolic volume phase of the heart (Ware, 2007).

## Materials and methods

For this study, 100 six-month to one-year adult, standard and young *Oryctolagus Cuniculus* (in Iran) (mean age of  $8.9 \pm 0.56$  in females and  $9.26 \pm 0.557$  in males) and in healthy appearance of both sexes (50 female rabbits and 50 male rabbits) with mean weight of  $2663.2 \pm 75.077$  in males and  $2517.2 \pm 86.65$  in females were studied without anesthesia and sedation.

To obtain a right parasternal view, the rabbits were placed on an echocardiographic table on the right side of their body and the echocardiographic probe was placed exactly on the shaved area (from the anterior to the end of pectoral area on the right side) on the right chest and all the required parameters were measured by Zoncare device (Zoncare Q9) and with transducer with phased array with the frequency of 7 to 9 MHz and then was statistically analyzed. The measurement of left ventricular diameter in diastole and the size of left ventricular internal diameter in systole was conducted using measuring instruments and the amount of blood drawn from the heart in each cardiac cycle or the same percentage of left ventricular ejection fraction (EF%) was calculated by the cube method according to the following formula: Ejection fraction =  $[(LVIDd^3 - LVIDs^3)/LVIDd^3] \times 100$  (Yang *et al.*, 1999).

## Statistical Data Analysis

The collected data were analyzed descriptively and analytically using SPSS software version 16. In order to analyze the data, Kolmogorov-Smirnov test, Chi square test and Mann-Whitney test were used.

## Results

In this study, the mean ejection fraction in *Oryctolagus Cuniculus* was  $58.753 \pm 6.889$  in the

male animals and  $61.397 \pm 6.530$  for the females which are comparable to the items mentioned in the

valid books and all the values obtained are listed in tables 1 and 2.

Sex	No.	Maximum	Minimum	Mean	Standard Deviation
male	50	69.10	45.70	58.7536	6.8892
female	50	72.70	47.70	61.3076	6.53087
Both Sexes	100	72.70	45.70	60.0756	6.80934

**Table 1.** Mean ejection fraction by sex in *Oryctolagus Cuniculus*.

Parameter	Minimum	Maximum	Mean	Standard Deviation
Weight/g	2000	3250	2590.20	302.978
Heartbeat/min	167	254	204.33	20.148
Internal dimension of the left ventricle (In diastole)/Mm	9.20	19.86	15.5428	2.969
Internal dimension of the left ventricle (In Systole)/Mm	6.35	14.92	10.970	2.253
Ejection fraction percentage	45.70	72.70	60.075	6.809

**Table 2.** Normal echocardiographic indices measured in *Oryctolagus Cuniculus* (in both males and females).

In this study, 50% of the studied rabbits were female and 50% male and the mean age of the evaluated rabbits was 9.8 months (range from 6 to 12 months). The mean age of female rabbits was not significantly different from male rabbits. The mean weight of male rabbits in this study was significantly higher than females (2517.20 g). In this study, the mean heart rate in 50 female rabbits was 207.66 (heart rate/min), which is significantly higher than 201 male rabbits (heart rate/min). The mean inner diameter of the left ventricle at the end of diastole is  $15.542 \pm 0.269$  mm, the mean left ventricular internal diameter in peak systole is  $10.970 \pm 0.225$  mm and the mean percentage of left ventricular ejection fraction was measured  $60.075 \pm 6.809$ . The left ventricular internal dimension measured in systole and diastole to obtain the ejection fraction in the assessed male

rabbits' population was significantly higher than the female rabbit population.

## Discussion

A study was conducted in Portugal in 2004 as “a measure of brightness mode and Doppler echocardiography in New Zealand white rabbits”. This study was performed on 52 male New Zealand male rabbit after anesthesia and the Echocardiography of left ventricular, left atrium and aortic motility and Doppler measurement of pulmonary current and aortic current were measured. Echocardiography of left ventricular, left atrium and aortic motility and Doppler measurement of pulmonary current and aortic current were measured. The results showed that the mean heart rate during echocardiography was  $155 \pm 29$  beats per

minute and the medium size in systole and diastole for left ventricular internal diameter and calculated  $10.25 \pm 1.22$  mm and  $14.37 \pm 1.49$  mm and the mean left ventricular ejection fraction was  $61.29 \pm 4.66$  %. In 2014, a similar study was conducted by Casamian-Sorrosal *et al.*, (2014) on 40 *Oryctolagus Cuniculus* and the statistical comparison of the ejection fraction index measured in domestic rabbits with the above-mentioned studies, which had evaluated normal echocardiographic indices in 52 and 40 rabbits, showed that there was no significant difference in the mean ejection fraction between the three studies (Fontes-Sousa *et al.*, 2006). Since a complete and accurate understanding of echocardiographic results requires having sufficient knowledge of the natural anatomy of cardiac sections and the existence of standard values of natural echocardiographic indices of different animals can be regarded as a reference, therefore, the mean values of the ejection fraction obtained in this study, which is an ideal indicator of ventricular contractile strength and shows the amount of blood drawn after the diastolic volume stage of the heart can be used as a reference for *Oryctolagus Cuniculus* echocardiographic tests in future clinical echocardiographic research and examinations.

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#### Conflict of interest

The authors state that there is no conflict of interest.

#### References

- Fontes-Sousa AP., Brás-Silva C., Moura C., Areias JC. and Leite-Moreira AF. M-mode and Doppler echocardiographic reference values for male New Zealand white rabbits. *Am J Vet Res*, 2006; 67(10): 1725-9. doi: 10.2460/ajvr.67.10.1725.
- Jacobs G. and Knight DH. M-mode echocardiographic measurements in nonanesthetized healthy cats: effects of body weight, heart rate, and other variables. *Am J Vet Res*, 1985; 46(8): 1705-11.
- Casamian-Sorrosal D., Saunders R., Browne WJ., Elliott S. and Fonfara S. M-mode, two-dimensional and Doppler echocardiographic findings in 40 healthy domestic pet rabbits. *J Vet Cardiol*, 2014; 16(2): 101-8. doi: 10.1016/j.jvc.2014.03.004.
- Slater JD. and Herrtage ME. Echocardiographic measurements of cardiac dimensions in normal ponies and horses. *Equine Vet J Suppl*, 1995; (19): 28-32. doi: 10.1111/j.2042-3306.1995.tb04986.x.
- Yang XP., Liu YH., Rhaleb NE., Kurihara N., Kim HE. and Carretero OA. Echocardiographic assessment of cardiac function in conscious and anesthetized mice. *Am J Physiol*, 1999; 277(5): H1967-74. doi: 10.1152/ajpheart.1999.277.5.H1967.
- Ware WA. Overview of echocardiography. In: *Cardiovascular disease in small animal medicine*. Manson Publishing Ltd, 2007; 68-90.



# تعیین میانگین طبیعی شاخص کسر جهشی به روش اکوکاردیوگرافی در خرگوش‌های اهلی

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## چکیده

**زمینه و هدف:** خرگوش‌های اهلی (*Oryctolagus cuniculus*) مدل بسیار خوبی برای تحقیقات قلب و عروق می‌باشند زیرا اندازه این حیوانات جهت مطالعه و آزمایشات نسبت به حیوانات کوچکتر، مناسب تر بوده و از لحاظ اقتصادی و هزینه‌های تحقیقاتی نیز مقرون به صرفه می‌باشند. یکی از مهمترین موارد تصویربرداری تشخیصی، روش‌های اکوکاردیوگرافی است که امروزه از این تکنیک جهت ارزیابی آناتومیکی و عملکردی سیستم قلبی عروقی استفاده می‌کنند و از دقیق‌ترین و حساس‌ترین روش‌های غیرتهاجمی جهت بررسی بیماری‌های قلب است. شاخص‌های عملکردی بطن‌ها را می‌توان با تکنیک‌های تصویربرداری قلبی ارزیابی کرد. یکی از این پارامترهای مهم قلبی می‌تواند به کسر جهشی که در کنار دیگر پارامترهای دخیل از جایگاه با ارزشی برخوردار است اشاره نمود. کسر جهشی (Ejection fraction) عبارت است از اندازه‌گیری درصد خونی که با هر انقباض، از قلب بیرون می‌آید.

**مواد و روش‌ها:** برای انجام این تحقیق تعداد ۱۰۰ سر خرگوش اهلی (در ایران) استاندارد بالغ و جوان شش ماه تا یک ساله و در ظاهر سالم از هر دو جنس (۵۰ سر خرگوش ماده و ۵۰ سر خرگوش نر) بدون بیهوشی و آرام بخشی مورد مطالعه قرار گرفت.

**یافته‌ها:** در این مطالعه میانگین کسر جهشی در خرگوش‌های نژاد اهلی مورد مطالعه در حیوان نر  $61/889 \pm 58/753$  و ماده  $61/397 \pm 6/530$  بدست آمد که نشان داد که کسر جهشی در جمعیت خرگوش‌های نر ارزیابی شده بصورت معنی داری بیشتر از جمعیت خرگوش‌های ماده است.

**نتیجه‌گیری:** مقادیر کسر جهشی اندازه‌گیری شده قابل قیاس با موارد ذکر شده در کتب معتبر بوده و در میانگین اندازه کسر جهشی اندازه‌گیری شده در این تحقیق اختلاف معنی داری با تحقیقات قبلی وجود ندارد.

**واژه‌های کلیدی:** اکوکاردیوگرافی، خرگوش اهلی، کسر جهشی، قلب

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