ARC Journal of Animal and Veterinary Sciences (AJAVS)
Volume 1, Issue 2, 2015, PP 27-32
ISSN 2455-2518 (Online)
www.arcjournals.org

Morphometric Analysis of the Skull of New Zealand Rabbit (Oryctolagus cuniculus L.) According to Gender

İftar Gürbüz[1], Yasin Demiraslan[2], Kadir Aslan[1]

[1]Department of Anatomy, Faculty of Veterinary Medicine, Kafkas University 36030, Kars, Turkey.
iftar@msn.com

[2]Department of Anatomy, Faculty of Veterinary Medicine Mehmet Akif Ersoy University 15030, Budur, Turkey.

Abstract: *The purpose of this study is to determine morphometrically the differences of the skulls of New Zealand rabbits according to their gender. In the study, 20 (10 female, 10 male) adult New Zealand rabbits were used. From the skulls of both genders, 19 different craniometric values were measured by using an electronic calliper (0.00, BTS, UK). Also craniofacial indexes were calculated in all the skulls. Mean, standard deviation, and correlation values of all the measurements obtained in the study were analysed in SPSS (20.0 version) programme. Accordingly, it is observed that the mean of the measurements taken except the skull width and aboral zygomatic width is higher in female animals. In terms of all the measurements, the differences between the genders were statistically insignificant (P> 0.05). Even though all the calculated skull index values were higher in males, the difference only between the skull index values was statistically significant (P< 0,05). As a result of the study, it was concluded that morphometric measurements in the skull of New Zealand rabbits cannot be used in gender differentiation.*

Keywords: *Morphometry, New Zealand rabbit, skull, gender*

1. Introduction

New Zealand Rabbit (Oryctolagus cuniculus L.) as the research material is a rodent animal from Craniata group of Chordata, Lagomorpha order, Laporidae family [1]. The rabbit has become a laboratory animal that is specifically preferred in scientific researches since it is easily reared and available.

Morphologic and morphometric studies performed on the skull both reflect the contribution of both genetics and the environmental factors in individual development and also constitute the basis of clinical and surgical practices [2]. The difference in the skull measurements is caused by not only the difference between the species and genera [3], but also the age and gender differences between different individuals of the same genus [4].

There are some previous morphologic and morphometric studies performed on the skulls of various animal species [5-9]. Although there are numerous morphometric studies conducted on rabbits [10-12], number of comparative macroanatomic studies conducted on gender factor is limited [13-15]. For this reason, the purpose of this study is to reveal the effect of the gender factor on morphometry of the skull among New Zealand rabbits.

2. Materials and Methods

In the study, totally 20 adult New Zealand rabbit skulls (10 females and 10 males), were used as the material. After the gluteus on the skulls was removed, classical maceration process was applied to the skulls [16]. Then, according to the method specified by Driesch (1976) [17], measurements were taken from 19 different locations of the skull by using the electronic calliper (0.01, BTS, UK). Indices were calculated by using the method defined by Onar et al. (2001) [18]. Mean, standard deviation, and correlation values of the measurements were analysed in SPSS (20.0 version) programme. Independent Samples T test was applied to determine the differences of the measurements performed on the skull between the genders. Driesch (1976) [17] and Nomina Anatomica Veterinaria (2012) [19] were taken as a basis for the denomination on the skulls.

2.1. Measurement points defined on the skull

Acrocranion (A). The most aboral point on the vertex of the cranium in the median plane, **Basion (**B). Orobasal border of foremen magnum in median plane, **Bregma** (Br). Median point of parietofrontal suture**, Euryon** (Eu). Most lateral point of braincase, **Lambda** (L). Median point of parietooccipital suture**, Nasion** (N). Median point of nasofrontal suture, **Otion** (Ot). Most lateral point of mastoid region, **Prosthion** (P). Most oral points of premaxillae on the median plane, **Postdentale** (Pd). Median point of the line combining the caudal edges of the last molar teeth alveoli on the median line of the oral cavity, **Rhinion** (Rh). Median point of the line combining the most oral points of nasals.

2.2 Measurements taken from the skull of New Zealand rabbit

L1. Skull length (acrocranion – prosthion), **L2.** Condylobasal length (aboral borders of occipital condyle - prosthion), **L3.** Basal length, **L4.** Dental length (postdentale – prosthion), **L5.** Largest nasal length, **L6.** Parietal length (lambda – bregma), **L7.** Frontal length (bregma – nasion), **L8.** Viscerocranium length (nasion – prosthion), **L9.** Length of the cheektooth row (measured along the alveoli on the buccal side), **L10.** Diestema length, **L11.** Palatal length, **L12.** Greatest width between the occipital condyles, **L13.** Widest length between the external acoustic meatus (otion – otion), **L14.** Maximum neurocranium width (euryon – euryon), **L15.** Skull width (distance between the temporal fossae) **L16.** Oral zygomatic width (between the oral parts of zygomatic arch) **L17.** Aboral zygomatic width (between the aboral parts of zygomatic arch), **L18.** Largest nasal width, **L19.** Palatal width

2.3. Craniofacial index values calculated on the skull

Nasal index (I1): Greatest breadth across the nasals x 100 / greatest length of the nasals

Facial index (I2): Maximum zygomatic width x 100 / viscerocranial length

Skull index (I3): Maximum zygomatic width x 100 / skull length

Neurocranium index (I4): maximum neurocranium width x 100 / neurocranium length

Basal index (I5): Maximum neurocranium length x 100 / basal length

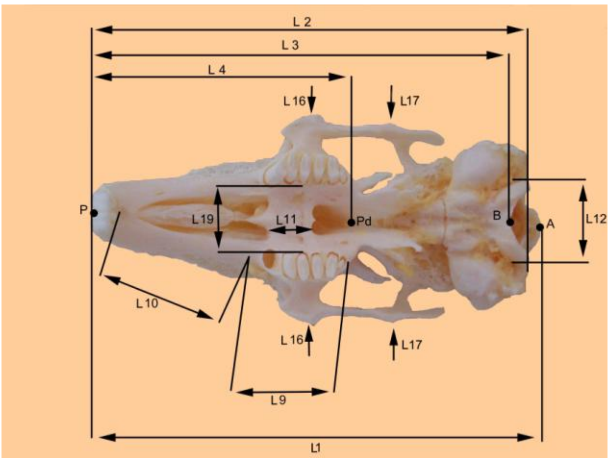

Fig1.*Skull measurement points in a New Zealand rabbit (view from the ventral)*

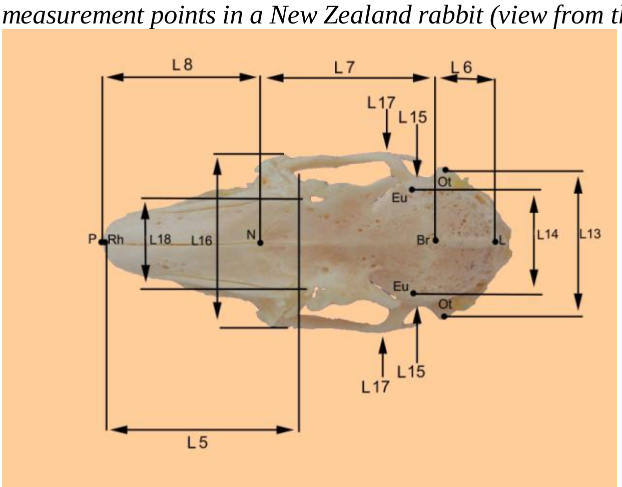

Fig2.*Skull measurement points in a New Zealand Rabbit (view from dorsal)*

3. RESULTS

In the study, table 1 illustrates the measurement values taken from skulls of the male and female New Zealand rabbits, table 2 illustrates craniofacial index values, table 3 illustrates correlation values of craniofacial indices, table 4 illustrates correlation values of the lengths measured from the skull and figures 1 and 2 illustrate the skull measurement points.

As a result of the study, it was determined that the skull length (L1) was 94.49 mm in females and 91.43 mm in males, skull width (L15) was 20.91 mm in females and 21.26 mm in males. Even though the mean values of the measurements taken except for the mean values of skull width (L15) and aboral zygomatic width (L17) were higher in female rabbits, no statistically significant difference was observed between the genders in terms of the mean values of all the measurements ($P > 0.05$). Although the craniofacial indices values were higher in male rabbits, only the difference between the genders in terms of the skull index (I3) value was statistically significant ($P < 0.05$).

It was determined that although there was a negative correlation between the skull length (L1) and skull width (L15) in female rabbits ($P > 0.05$), there were a positive correlation between the skull length (L1) and all the other measurements. It was specified that there was a weak positive correlation between the skull length (L1) and the skull width (L15) in male rabbits compared to the female rabbits.

It was determined that there was a statistically strong positive correlation between the skull length (L1), condylobasal length (L2), and basal length (L3) in male and female rabbits ($P < 0.01$).

In male and female rabbits, it was observed that there was a strong positive correlation between the largest nasal width (L18) and parietal length (L6) ($P < 0.01$).

It was observed that there were a strong positive correlation between the frontal length (L7) and viscerocranium length (L8) in female rabbits and a strong negative correlation in male rabbits and the correlation values were statistically significant ($P < 0.01$).

In male and female rabbits, it was specified that the strong positive correlation between the neurocranium index (I4) and facial index (I2) had a significant value ($P < 0.01$).

Table 1.*Mean and standard deviation values of the skull measurements in terms of gender*

Measurements taken from the skull of New Zealand rabbit	Female (mm)	Male (mm)	Measurements taken from the skull of New Zealand rabbit	Female (mm)	Male (mm)
L1	94.49±3.95	91.43±2.29	**L11**	9.17±0.68	8.79±0.31
L2	84.74±3.81	82.36±2.14	**L12**	17.53±1.05	16.96±0.67
L3	79.46±5.11	76.35±2.23	**L13**	28.23±1.37	27.41±0.21
L4	47.45±2.01	46.72±0.98	**L14**	24.53±0.56	24.22±0.70
L5	43.86±2.80	42.80±1.71	**L15**	20.91±0.89	21.26±0.53
L6	18.14±1.42	17.37±0.45	**L16**	41.32±1.42	40.88±0.64
L7	33.17±1.81	32.46±0.41	**L17**	41.24±1.16	42.27±0.88
L8	45.80±2.41	45.50±0.89	**L18**	17.18±1.05	17.17±0.39
L9	16.25±0.66	15.93±0.49	**L19**	12.48±0.60	12.20±0.53
L10	27.49±1.40	26.67±0.96			

Table 2.*Mean and standard deviation values of craniofacial indices in terms of genders ("*" $P < 0.05$)*

Craniofacial indexes in New Zealand rabbit	Female	Male
I1. Nasal index	39.26±2.97	40.17±1.70
I2. Facial index	90.23±5.11	92.84±2.47
I3. Skull index*	**43.69±1.77***	**46.24±0.77***
I4. Neurocranium index	52.97±2.46	53.59±1.37
I5. Basal index	30.58±2.05	32.14±1.10

Table 3.*Correlation values of craniofacial indexes in female and male New Zealand rabbits (↓ female New Zealand rabbit, → male New Zealand rabbit, "*" P< 0.05)*

→ ↓	I1	I2	I3	I4	I5
I1		.243	.235	.530	.834**
I2	.622		.085	.911**	-.191
I3	.368	.874**		.337	.453
I4	.137	.815**	.820**		.167
I5	-.654*	-.074	.327	.429	

Table 4.*Correlation values of the lengths measured in the skulls of female and male New Zealand rabbits (↓ lengths measured from the skull of female New Zealand rabbits, → lengths measured from the skull of male New Zealand rabbits, "*" P< 0.05, "**" P< 0.01)*

→ ↓	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19
L1		.864**	.840**	.569	.214	.017	-.532	.125	-.029	.527	.273	-.462	.235	.330	.656*	.144	.748*	.058	-.082
L2	.931**		.992**	.794**	.188	-.230	-.191	-.192	.234	.673*	.230	-.300	.108	.222	.293	-.011	.725*	-.136	-.173
L3	.795**	.925**		.770**	.244	-.140	-.205	-.170	.147	.689*	.234	-.366	.146	.261	.285	.029	.786**	-.039	-.144
L4	.960**	.830**	.690*		.457	-.550	.120	-.205	.528	.905**	-.368	.272	-.515	-.385	-.188	-.613	.300	-.462	.155
L5	.647*	.365	.080	.761*		.290	-.313	.528	-.337	.786**	-.702*	-.010	-.471	-.380	-.044	-.470	.330	.278	.934**
L6	.755*	.756*	.574	.664*	.535		-.631	.600	-.997**	-.203	.242	-.783**	.587	.557	.529	.642*	.498	.944**	.401
L7	.800**	.664*	.465	.697*	.600	.593		-.849**	.669*	-.078	-.184	.660*	-.423	-.419	-.898**	-.406	-.575	-.431	-.269
L8	.834**	.600	.357	.843**	.884**	.641*	.877**		-.658*	.091	-.270	-.305	.035	.017	.562	.063	.204	.348	.614
L9	.631	.394	.161	.707*	.863**	.342	.614	.806**		.170	-.188	.760*	-.543	-.509	-.542	-.598	-.488	-.924**	-.449
L10	.937**	.817**	.664*	.978**	.731*	.626	.679*	.822**	.632		-.535	.119	-.522	-.386	-.123	-.592	.425	-.135	.534
L11	.718*	.681	.536	.585	.421	.588	.755*	.727*	.521	.581		-.682*	.926**	.883**	.533	.893**	.400	.281	-.770**
L12	.788**	.541	.305	.789**	.861**	.613	.892**	.993**	.782**	.760*	.712*		-.874**	-.868**	-.757*	-.856**	-.833**	-.780**	.071
L13	.392	.210	-.025	.313	.606	.566	.674*	.713*	.589	.232	.658*	.759*		.948**	.663*	.991**	.545	.581	-.487
L14	.320	.087	-.020	.393	.537	.005	.505	.494	.658*	.297	.005	.525	.323		.655*	.927**	.620	.575	-.437
L15	-.494	-.641*	-.791**	-.513	.046	-.185	.046	-.013	-.101	-.498	-.173	.076	.447	.140		.635*	.606	.400	-.120
L16	.635*	.531	.420	.524	.392	.278	.877**	.684*	.647*	.461	.690*	.707*	.572	.612	-.031		.476	.636*	-.442
L17	.419	.536	.701*	.241	-.229	.226	.438	.138	.057	.137	.437	.162	.163	.183	-.389	.639*		.550	.086
L18	.792*	.835**	.782**	.649*	.292	.874**	.690*	.569	.165	.610	.584	.563	.413	.068	-.289	.449	.575		.355
L19	.538	.578	.461	.384	.190	.287	.689*	.424	.528	.319	.570	.418	.390	.457	-.168	.869**	.636*	.392	

4. DISCUSSION

In the literature, the length of the skull of the New Zealand rabbit is specified as ave. 94.1 mm [20] and the skull length of blind mice is ave. 42.5 mm [21]. Olude et al. (2009) [22], calculated the length of the skulls in female and male rats as ave. 63.6 mm and 62.8 mm, respectively. Compatible with Monfared (2013) [20]; the skull length in female and male rabbits was calculated as ave. 94.49 mm and 91.43 mm, respectively in the study. As a result of this study, it was specified that these values did not comply with the skull measurements of the rodent animals [21, 22].

Hughes et al. (1978) [23], reported that the skull measurements were significantly larger in male rats compared to the female rats and Galatius (2005) [24], specified that the skull measurements of harbour porpoise (Phocoena phocoena) were significantly higher in females compared to the males. Also, Salih (2013) [25], determined that the mean of 10 among totally 16 lengths measured from the rabbit skulls was higher in female rabbits compared to the male rabbits and the difference between the genders in terms of some lengths (for example; distance between two arcus zygomaticus and the maxillo alveolar distance) was statistically significant. In the study, it was determined that except for 2 of totally 19 lengths measured (skull width (L15) and aboral zygomatic width (L17)), all the other lengths were higher in female rabbits and contrary to the researchers [23-25], there were no significant differences between the genders in terms of the skull lengths (P> 0.05).

Olude et al. (2009) [22], specified that the skull index calculated as 29.10±0.35 and 27.71±1.09 respectively in female and male rats was statistically insignificant between genders (P> 0.05). In the study, the skull index was found as 43.69±1.77 and 46.24±0.77 in female and male rabbits, respectively. Contrary to the researchers [22], it was observed that the skull index value obtained was significantly higher in male rabbits compared to the female rabbits (P< 0.05).

In a morphometric study conducted by Onar et al. (1997) [4], in the skulls of German Shepherd dogs, they found that there was a strong positive correlation (P< 0.01) between the skull index and facial index. In accordance with the determinations of Onar et al. (1997) [4], it was observed in the study that there were a strong positive correlation between the skull index and facial index in female rabbits (P< 0.01) and a weak positive correlation in male rabbits (P> 0.05).

As a result of the study, it was concluded that morphometric measurements taken from the skull of New Zealand rabbits cannot be used in gender differentiation. It is thought that the results obtained in the study may contribute to the morphometry of rabbit skulls and may be a data source for future zoo-archaeological excavations.

ACKNOWLEDGEMENTS

This study has been presented as a poster in VIII. National (International participation) Veterinary Anatomy Congress organized in Istanbul at 25-28 June 2013.

REFERENCES

[1]. Demirsoy, A., Yaşamın Temel Kuralları. Omurgalılar (Sürüngenler, Kuşlar ve Memeliler), 1st ed. Meteksan AŞ, Ankara, (1992).

[2]. Wehausen, J.D. and Ramey, R.R., Cranial morphometric and evolutionary relationships in the nothern range of Ovis canadensis, J. Mammal. **81 (1),** 145-161, (2000).

[3]. Özcan, S., Aksoy, G., Kürtül, İ., Aslan, K. and Özüdoğru, Z., A comparative morphometric study on the skull of the Tuj and Morkaraman Sheep, Kafkas Univ. Vet. Fak. Derg. **16 (1),** 111-114, (2010).

[4]. Onar, V., Mutuş, R. and Kahvecioğlu, K.O., Morphometric analysis of the foramen magnum in German Shepherd dogs (Alsatians), Ann. Anat. **179 (6),** 563-568, (1997).

[5]. Onar, V., Kahvecioğlu, K.O. and Cebi, V., Computed tomographic analysis of the cranial cavity and neurocranium in the German shepherd dog (Alsatian) puppies, Veterinarski Arhiv. **72 (2),** 57-66, (2002).

[6]. Olopade, J.O. and Onwuka, S.K., Morphometric study of the skull of the west African Dwarf Goat from South West Nigeria, Niger. Vet. J. **26 (2),** 18-21, (2005).

[7]. Onar, V., Belli, O. and Owen, P.R., Morphometric examination of Red Fox (Vulpes vulpes) from the Van-Yoncatepe necropolis in Eastern Anatolia, Int. J. Morphol. **23 (3),** 253-260, (2005).

[8]. Uddin, M., Sarker, M.H.R., Hossain, M.E., Islam, M.S., Hossain, M.B. and Shill, S.K., Morphometric investigation of neurocranium in domerstic cat, Bangl. J. Vet. Med. **11 (1),** 69-73, (2013).

[9]. Çakır, A., Yıldırım, I.G. and Ekim, O., Craniometric measurements and some anatomical characteristics of the cranium in Mediterranean Monk seal (Monachus monachus, Hermann 1779), Ankara Üniv. Vet. Fak. Derg. **59,** 155-162, (2012).

[10]. Özkan, Z.E., Dinç, G. and Aydın, A., Tavşan (Oryctolagus cuniculus), kobay (Cavia porcellus) ve ratlarda (Rattus norvegicus) scapula, clavicula, skeleton brachii ve skeleton antebrachii'nin karşılaştırmalı gross anatomisi üzerinde incelemeler, Fırat Üniv. Sağ. Bil. Derg. **11,** 171-175, (1997).

[11]. Kahvecioğlu, K.O., Onar, V., Alpak, H. and Pazvant, G., The morphometry of the Foramen magnum in rabbits and its correlation with craniometric measurements, Folia Vet. **44 (2),** 62-69, (2000).

[12]. Abreu, A.T., Veeck, E.B. and Costa, N.P., Morphometric methods to evaluate craniofacial growth: study in rabbits, Dentomaxillofac.Radio. **35 (2),** 83-87, (2006).

[13]. Taylor, J., Freedman, L., Oliver, T.J. and McCluskey, J., Morphometric differences between Australian wild rabbit populations, Aust. J. Zool. **25 (4),** 721-732, (1977).

[14]. Özkadif, S., Yeni Zelanda Tavşanlarında Sinus Paranasales'in Multidedektör Bilgisayarlı Tomografi Görüntülerinin Üç Boyutlu Rekonstrüksiyonu, Selçuk Üniv. Sağ. Bil. Ens. Doktora Tezi, Konya, (2011).

[15]. Akbulut, Y., Demiraslan, Y., Gürbüz, İ. and Aslan, K., Yeni Zelanda tavşanı (Oryctolagus cuniculus L.)'nda cinsiyet faktörünün mandibula morfometrisine etkisi, Fırat Üniv. Sağ. Bil. Vet. Derg. **28 (1),** 15-18, (2014).

[16]. Taşbaş, M. and Tecirlioğlu, S., Maserasyon tekniği üzerinde araştırmalar, Ankara Univ. Vet. Fak. Derg. **12 (4),** 324-330, (1966).

[17]. Von Den Driesch, A., A Guide to the measurement of animal bones from archaeological sites, Peabody Museum Bulletin I. Cambridge M.A. Harvard University, Pp. 50-51, (1976).

[18]. Onar, V., Özcan, S. and Pazvant, G., Skull typology of adult male Kangal dogs, Anat. Histol. Embriyol. **30 (1),** 41-48, (2001).

[19]. International Committe on Veterinary Gross Anatomical Nomenclature, General Assembly of the World Association on Veterinary Anatomists. Nomina Anatomica Veterinaria. 5th ed. Gent, (2012).

[20]. Louei Monfared, A., Applied of the Rabbit's skull and its clinical application during regional anesthesia, Global Vet. **10 (6),** 653-657, (2013).

[21]. Özkan, Z.E., Macro-anatomical investigations on the skeletons of mole-rat (Spalax leucodon Nordmann) III. Skeleton axiale, Veterinarskii arhiv. **77 (3),** 281-289, (2007).

[22]. Olude, M.A., Olopade, J.O., Fatola, I.O. and Onwuka, S.K., Some aspects of the neurocraniometry of the African giant rat (Cricetomys gambianus Waterhouse), Folia Morphol. **68 (4),** 224-227, (2009).

[23]. Hughes, P.C.R., Tanner, J.M. and Williams, J.P.G., A longitudinal radyographic study of the growth of the rat skull, J. anat. **127 (1),** 83-91, (1978).

[24]. Galatius, A., Sexually dimorphic proportions of the Harbour Porpoise (Phocoena phocoena) skeleton, J. anat. **206 (2),** 144-154, (2005).

[25]. Salih, K.M., Gross anatomical and morphometrical studies to the skull bones of the local rabbit (Oryctohguscuniculus), Bas. J. Vet. Res. **12 (2),** 267-277, (2013).

AUTHORS' BIOGRAPHY

İftar Gürbüz, Research Assistant,

Department of Anatomy, Fakulty of Veterinary Medicine,

Kafkas University, Kars, Turkey.

Yasin Demiraslan, Assistant Professor,

Department of Anatomy, Fakulty of Veterinary Medicine, Mehmet Akif Ersoy University, Burdur, Turkey.

Kadir Aslan, Professor, Department of Anatomy, Fakulty of Veterinary Medicine, Kafkas University, Kars, Turkey.