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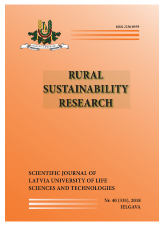

Assessment of Maximum Cross - Sectional Area and Volume of the Canine Biceps Brachii – Brachialis Muscles

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Abstract. The biceps brachii - brachialis muscles has attachment on the medial coronoid process (MCP) and proximal radius. It is considered that medial coronoid disease (MCD) can be caused by biceps brachii – brachialis muscle generated force to MCP. Computed tomography data from 31 dogs were analysed. The aim of this study was to compare biceps brachii – brachialis muscle volume and maximum cross-sectional area (mCSA) between clinically normal dogs to dogs with a MCD. Results showed that in dogs with MCD, biceps brachii - brachialis muscle volume and mCSA is smaller than in clinically normal dogs and therefore the generated muscle force cannot be considered as the main or accompanying cause of a MCD.
Key words: dysplasia, medial coronoid, tomography, canine.

Introduction

In a canine orthopaedics, one of the actual problems is medial coronoid disease (MCD). MCD is a part of canine elbow dysplasia and this disease includes several pathologies of the medial coronoid process (MCP), such as sclerosis, microfractures, fragmentation or fissuring and cartilage damage with or without joint incongruity (Fitzpatrick & Danielski, 2010; Michelsen, 2013). MCD often affects young, large and giant breed dogs (Michelsen, 2013). It is considered that MCD development starts between four to five months of age (Breit *et al.*, 2004). MCD can be caused by several factors: disturbed development of endochondral ossification, abnormalities of trabecular bone, joint incongruity and genetics play a role (Temwichitr *et al.,* 2010). It is considered that MCD can be caused by biceps brachii – brachialis muscles generated force to MCP (Fitzpatrick & Yeadon, 2009; Michelsen, 2013).

The biceps brachii - brachialis muscles has attachment on the MCP and a smaller one on the proximal radius (Fitzpatrick & Danielski, 2010). Muscles and bones are anatomically and functionally closely related. During movements, skeletal muscles deliver load to a bone and transform skeletal segments (Cianferotti & Brandi, 2014). According to the mechanostat theory, muscles are important for bone development and upkeep (Cianferotti & Brandi, 2014).

The aim of this study was to determine and compare biceps brachii – brachialis muscles (BBM – BM) volume and maximum cross-sectional area (mCSA) between clinically normal and dogs with MCD and to determine the relationship between BBM - BM volume and mCSA.

Materials and Methods

The study was performed at the Veterinary hospital of Latvia University of Life Sciences and Technologies (LLU). LLU Animal Welfare and Protection Ethics Council reviewed the study protocol and waived approval for this study (LLU DZLAP Nr.18/1). Animal owners have agreed that data of their dogs are used for this research.

Inclusion criteria

Large to giant breed (> 20 kg), age from six to 30 months, dogs with MCD were considered for inclusion in the group A. All dogs had general clinical and orthopaedic examination, computed tomography (CT) of the elbow and shoulder joints. CT findings were considered appropriate with MCD included subchondral sclerosis, formation of bone spurs, joint surface unevenness and fragmentation of MCP.

Control group criteria

Large to giant breed (> 20 kg), at age from six to 30 months with normal elbows and shoulders. All dogs

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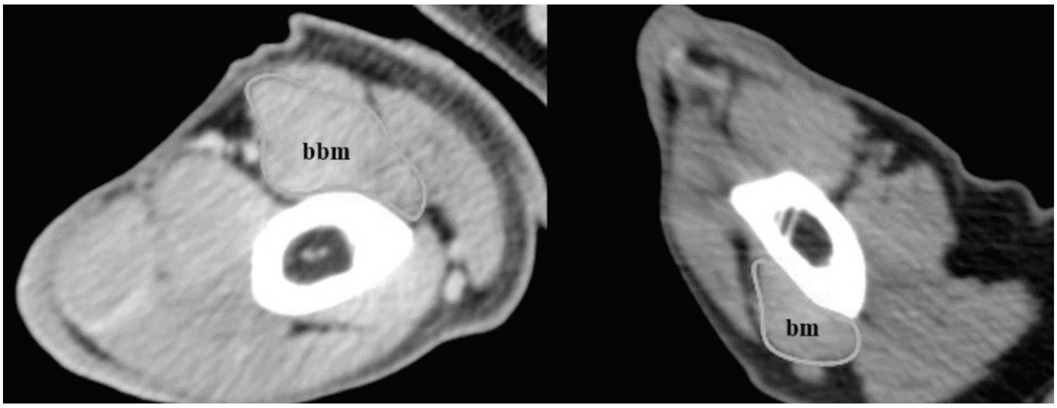

Figure 1. Biceps brachii (bbm) and brachialis (bm) muscle maximum cross sectional area measurement technique in a CT transversal view.

had general clinical and orthopaedic examination, CT of the elbow and shoulder joints. Inclusion criteria in the control group required the lack of elbow dysplasia based on anamnesis, orthopaedic examination and elbow/shoulder tomography. In a control group, dogs did not have CT findings considered with elbow disease.

CT study

Computed tomography was performed using Philips MX-16 scanner with 140 kV, 250 mAS, 16*0.75 collimator, 0.75 mm slice thickness and 1 second rotation time. All included dogs were anesthetized and positioned in ventral recumbence. Anaesthesia protocol for each dog was individually adapted. Both forelegs were positioned in extension. We set CT scanning area from shoulder joints to ~ 5 cm distal from radius head. CT examinations were performed before and after contrast media (*iopromide 370 mgr I ml^{-1})* intravenous administration (2 ml kg^{-1}).

Morphometric techniques

Three dimensional multiplanar reconstruction (MPR) views were obtained using Horos v2.2.0 software. For muscle volume determination we used a closed polygon function: a cross-sectional area in a full length of muscle was established with 5 mm interval and missing values were calculated by ROI Volume Generate Mission ROIs function. The mCSA was measured with a closed polygon function at the widest place of the muscles (Figure 1). In our study due to the position, the widest place of biceps brachii and brachialis muscles in CT reconstructions were at the level of second to third cervical vertebrae. The maximum cross-sectional area was measured in three places and a larger value of these measurements was set as a maximum cross-sectional area. All measurements were performed in the true perpendicular plane in relation to muscle orientation.

Statistical analysis

Statistical analysis was performed with Microsoft Office Excel 2015 and Rstudio 1.1.456. software. Descriptive statistics were used to describe measurement values. Strength of a relationship between biceps brachii and brachialis muscle volume and mCSA different parameters were interpreted as negligible (<0.30), low (0.31– 0.50), moderate (0.51 – 0.70), high (0.71 – 0.90), very high (0.91 – 1.00). A t-test was used to compare biceps brachii muscle (BBM) and biceps muscle (BM) volume and mCSA between patient groups. P-values < 0.05 were considered statistically significant.

Results

CT data from 31 dog were analysed in this study. In a group A, 21 dog had MCD and in a group B 10 dogs were without any orthopaedic disease. In the group A, 17 males and 4 female dogs were included with an average age of 14.1 ± 9.15 months and medium body weight 35.6 ± 9.47 kilograms (kg), seven different breeds were included: Labrador retriever (n=9), German shepherd dog (n=6), Rottweiler (n=2), Barnes mountain dog (n=1), Newfoundland dog (n=1), Central Asian shepherd dog (n=1), mixed breed (n=1). The Group B consisted of 7 male and 4 female dogs with an average age of 17.0 ± 8.05 months and with an average body mass was 38.9 ± 8.87 kg, six different dog breeds were included: German shepherd dog (n=3), Labrador retriever (n=2), Barnes mountain dog (n=1), Cane Corso (n= 2), Pyrenees mountain dog (n=1), Central Asian Shepherd dog (n=1). There was no statistically significant difference between the dog weight (p>0.05). Table 1 demonstrates the descriptive statistics of the BBM and BM muscle volume and mCSA of Groups A and B.

BM and BBM mCSA area in a control group dogs were greater than in dogs with an MCD. T-test results demonstrated that BBM mCSA values between groups were significantly different (p<0.05), but BM

Table 1

Summary of descriptive statistics for BBM and BM volume and maximum cross-sectional area

Parameter		Group A	Group B
		Average ± SD	Average ± SD
BBM Volume (cm^3)	Male and female	31.45 ± 10.435	39.65 ± 6.141
	Male	32.10 ± 11.089	38.46 ± 6.474
	Female	28.48 ± 6.279	42.03 ±5.085
BBM mCSA (cm^2)	Male and female	4.77 ± 1.203	5.82 ± 0.961
	Male	4.92 ± 1.187	5.67 ± 1.086
	Female	4.09 ± 1.063	6.17 ± 0.478
BM Volume (cm^3)	Male and female	19.02 ± 7.700	20.03 ± 5.868
	Male	20.0 ± 7.800	22.10 ± 5.567
	Female	13.59 ± 4.412	15.21 ± 3.232
BM mCSA (cm^2)	Male and female	2.35 ± 0.841	2.64 ± 0.587
	Male	2.40 ± 0.809	2.71 ± 0.522
	Female	2.15 ± 0.966	2.47 ± 0.747

Standard deviation (SD)

values were without a significant difference (p>0.05). The analysis of variance demonstrated similar results as t-test, i.e. there existed a significant difference between BBM mCSA, but BM values between groups were similar.

In the group A, BBM mCSA has a moderate positive correlation with age (r=0.56; p<0.05), breed (r=0.62; p<0.05) and body weight (r=0.68; p<0.05). BM mCSA has a high positive correlation with body weight (r=0.82; p<0.05) and dogs breed (r=0.72; p<0.05), but low relationship with age (r=0.46; p<0.05). In the Group B, in the muscle mCSA there was not a significant correlation in any of the parameters.

BBM volume was greater in the control group dogs, with a significant difference (p<0.05) between groups. In the Group A, there was a moderate correlation between BBM volume and body weight (r=0.63; p<0.05) and age (r=0.59; p<0.05) and weak relationship between BM volume and body weight (r=0.45; p<0.05) and age (r=0.36; p<0.05). In the Group B, there was a weak correlation between BM volume and dogs body weight (r = 0.45; p<0.05) and age (r=0.36; p<0.05) and no significant correlation between BBM volume and correlation parameters.

In the Group A, there was a high correlation between BBM mCSA and volume (r=0.81; p<0.05) and amidst BM volume and mCSA (r=0.79; p<0.05). In the Group B, there was no significant correlation between both muscle volume and mCSA. Analysing both group values together, we determined that BBM have a high correlation between the volume and mCSA (r=0.76; p<0.05), but BM volume had a negligible correlation between the volume and mCSA (r=0.29; p<0.05).

Discussion

The aim of this study was to compare biceps brachii – brachialis muscle volume and maximum cross-sectional area (mCSA) between clinically healthy dogs to dogs with MCD and also determine the relationship between biceps brachii – brachialis muscle volume and mCSA. All included dogs were large or giant breed at the age of six to 30 months. Our study patient groups were similar to studies previously carried out (Groth *et al.*, 2009). Six months as minimal age was chosen because in dogs at 20 – 22 weeks of age normal endochondral ossification of MCD ends (Breit *et al.*, 2004). As a maximum age limit, we chose 30 weeks to avoid age-related degenerative changes in joints. It is considered that physiological age-related changes in joints start from 60 months of age in a large breed dogs (Jones & Inzana, 2000). Dog breeds, included in the study, were similar to the studies carried out previously. MCD mostly affects German shepherd dogs, Bernese mountain dogs, Labradors Retrievers, golden retrievers and Rottweilers (Hazewinkel, 2014; Jones & Inzana, 2000; Morgan *et al.*, 1999). All these breeds were included in our study with a prevalence of German shepherd dogs, Labradors Retrievers, Golden retrievers and Bernese mountain dogs. It is described that male dogs are more often affected (Michelsen, 2013) and that is also indicated in our studies.

In general, the results of this study demonstrated differences in muscles volume and the mCSA between dogs with MCD and the control group. However, the results obtained are not unambiguous and in relation with MCD should be evaluated with caution. It is considered that muscle mass increase causes larger pressure to tendons and secondary to bones and can cause internal shear stress with secondary damages (Nyman *et al*., 2009). Hueter - Volksmann theory states that increasing load to bones cause a disturbance in an endochondral ossification (Stokes, 2002). Based on this theory, it could also be extended to MCD, but in our study, BBM and BM volume was greater in the control group dogs and it follows that we reject the claim, that dogs with MCD have larger BBM and BM mass. This is also evidenced by the fact that in dogs with unilateral MCD, BBM and BM volume and maximum – the cross-sectional area was without a significant difference between legs.

It was essential to find out whether BBM and BM muscles volume correlates with the mCSA. Our study results presented that in the Group A BBM and BM volume had a significant correlation with mCSA, but in the Group B, there was no significant difference.

Conclusion

We cannot reject that biceps brachii – brachialis muscle have an impact in the development of a medial coronoid disease in dogs, but our study results show that muscle volume and mCSA cannot be considered as the main cause of development of a medial coronoid disease.

References

1. Breit, S., Künzel, W., & Seiler, S. (2004). Variation in the ossification process of the anconeal and medial coronoid processes of the canine ulna. *Research in Veterinary Science*, *77*(1), 9–16. DOI: 10.1016/j.rvsc.2004.02.003.
2. Cianferotti, L., & Brandi, M. L. (2014). Muscle-bone interactions: Basic and clinical aspects. *Endocrine*. DOI: 10.1007/s12020-013-0026-8.
3. Fitzpatrick, N., & Danielski, A. (2010). Biceps ulnar release procedure for the treatment of medial coronoid disease in 164 elbows. In Sarah Girling (Ed.), *New horizons in thoracic limb surgery* (pp. 71–73). Dublin: British Veterinary Orthopaedic Association. Retrieved September 21, 2018, from http://www.bsavaportal.com/Portals/5/BVOA/files/BVOA Proceedings Dublin meeting Autumn 2010.pdf?ver=2017-07-06-051859-040#page=72.
4. Fitzpatrick, N., & Yeadon, R. (2009). Working algorithm for treatment decision making for developmental disease of the medial compartment of the elbow in dogs. *Veterinary Surgery*, *38*(2), 285–300. DOI: 10.1111/j.1532-950X.2008.00495.
5. Groth, A. M., Benigni, L., & Moores, A. P., Lamb, C. R. (2009). Spectrum of computed tomographic findings in 58 canine elbows with fragmentation of the medial coronoid process. *Journal of Small Animal Practice*, *50*(1), 15–22. DOI: 10.1111/j.1748-5827.2008.00656.x.
6. Hazewinkel, D. (2014). Elbow Dysplasias: different entities and their etiologies, incidence and prevalence and genetic aspects. In *28th annual meeting of the International Elbow Working Group* (pp. 7–13). Cape Town. Retrieved September 2, 2018, from http://www.vet-iewg.org/wp-content/uploads/2017/02/proceedings2014.pdf.
7. Jones, J. C., & Inzana, K. D. (2000). Subclinical CT abnormalities in the lumbosacral spine of older large-breed dogs. *Veterinary Radiology & Ultrasound*, *41*(1), 19–26. DOI: 10.1111/j.1740-8261.2000.tb00421.
8. Michelsen, J. (2013). Canine elbow dysplasia: Aetiopathogenesis and current treatment recommendations. *The Veterinary Journal*, *196*(1), 12–19. DOI: 10.1016/j.tvjl.2012.11.009.
9. Morgan, J., Wind, A., & Davidson, A. (1999). Bone dysplasias in the labrador retriever: a radiographic study. *Journal of the American Animal Hospital Association*, *35*(4), 332–340. DOI: 10.5326/15473317-35-4-332.
10. Nyman, J. S., Leng, H., & Neil Dong, X., Wang, X. (2009). Differences in the mechanical behavior of cortical bone between compression and tension when subjected to progressive loading. *Journal of the Mechanical Behavior of Biomedical Materials*, *2*(6), 613–619. DOI: 10.1016/j.jmbbm.2008.11.008.
11. Stokes, I. A. F. (2002). Mechanical effects on skeletal growth. *Journal of Musculoskeletal Neuronal Interactions*, *2*(3), 277–280. Retrieved September 2, 2018, from http://pgocclusion.com/files/Stokes.pdf.
12. Temwichitr, J., Leegwater, P. A. J., & Hazewinkel, H. A. W. (2010). Fragmented coronoid process in the dog: A heritable disease. DOI: 10.1016/j.tvjl.2009.06.022.

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