Article
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GONIOMETRIC MEASUREMENTS OF THE FEMORAL JOINT IN DOGS WITH HIP DYSPLASIA

Teodora-Sonia PATRICHI [1+], Felix-Daniel LUCACI [1+], Anamaria COSTIN[1], Caroline-Maria LĂCĂTUȘ[1], Sorin-Marian MÂRZA [1], Robert Cristian PURDOIU [1*], Mihai MUSTEAȚĂ[2], Radu LĂCĂTUȘ [1]

1. University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania
2. University of Life Sciences "Ion Ionescu de la Brad", Iași, Romania

* Corresponding author: robert.purdoiu@usamvcluj.ro
\+ These authors contributed equally to this work

Abstract

Canine hip dysplasia is one of the most common orthopedic dieseases presents in most breeds of dogs but more prevalent in large breeds. Clinical examination through tests such as Ortolani, Barlow, and Bardens, alongside with radiological, tomographic, magnetic resonance, and ultrasonographic examinations, are the only methods for screening and diagnosing canine hip dysplasia. Canine hip dysplasia can lead to other musckuloskeletal diseases, with the most common ones being cruciate ligaments tear and spinal conditions such as IVDD or degenerative myelopathy. To assess hip changes, it is recommended that the patient to be heavily sedated, and the standard exposure will be with the hips in forced extension. Among knee conditions related to hip dysplasia, the most commonly reported are patellar luxation, partial cranial cruciate ligament rupture, and osteoarthritic changes. A study conducted on 65 dogs found concurrent hip dysplasia and patellar luxation in 28% of cases. Clinical goniometry is an objective and non-invasive method of measuring joint angles, allowing for the assessment of the normal range of joint movements. This method can indicate the severity of joint pathology. Currently, goniometry is often used in the field of imaging and it can be an important element in assessing the musculoskeletal system. The aim of this paper is to evaluate the effectiveness of goniometric measurements at the knee and hip joint levels in dogs with hip dysplasia and if there is a correlation. A total of 10 dogs from varying breeds of dogs aging from 1 to 3 years old, were deeply sedated in order to measure perform the x-rays in ventro-dorsal hip extended view for measuring the Norberg angle (Na), anatomic Latero-Proximal Femoral Angle (aLPFA), anatomic Latero-Distal Femoral Angle (aLDFA), mechanical Latero-Distal Femoral Angle (mLDFA), mechanical Latero-Proximal Femoral Angle (mLPFA). All patients were part of the clinical cases present in our department and the written consent of the owners was obtained for each dog. Norberg and femoral angles were measured within the local DICOM viewer and the statistical analysis was performed with IBM SPSS Statistics. All images were reviewed by an ECVDI resident, a radiology professor and a radiology intern. All patients within our study had a Na under the reference value of 105º. All the femoral angles were within limits regarding their normal values. We conclude that there is not a signicative relation between the Na and the goniometric values obtained, most likely because of other factors that are influencing these measurements (ex. breed variations, femoral slightly rotation, muscle contracture due to poor anesthesia management, other musculoskeletal genetic disorders etc.). Further research on a more relevant statistical sample is recommended, in order to determine the normal goniometric values and the changes that appear in case of hip dysplasia.

Keywords: hip dysplasia, Norberg angle, musculoskeletal diseases, goniometric measurements

Introduction

Canine hip dysplasia is a complex, polygenic condition found in most dog breeds but more prevalent in large breeds. It occurs in young dogs and can lead to the development of osteoarthritis in advanced cases (Mikkola L, 2021). Since 1935, when it was first described by Schnelle, the entire veterinary community has been and continues to be engaged in the battle to control and reduce the occurrence of canine hip dysplasia because it has a significant impact on the well-being of the patient and indirectly on the owner (King M, 2019; Mikkola L, 2020).

Clinical examination conducted through tests such as Ortolani, Barlow, and Bardens, along with radiological, tomographic, magnetic resonance, and ultrasonographic examinations, remains, for now, the only methods for screening and diagnosing canine hip dysplasia, especially in young patients (Butler and Gambino, 2017).

Canine hip dysplasia can also lead to comorbidities, with the most common ones being ruptured cruciate ligaments and spinal conditions such as IVDD or degenerative myelopathy (DeCamp et al., 2016).

To assess hip changes, it is recommended that the patient be sedated, and the standard exposure will be with the hips in forced extension. It is known that in this exposure, the femoral head is practically "forced" by joint tension elements to be positioned as deeply as possible in the acetabular cavity, a phenomenon known as 'screw-home.' This phenomenon can lead to false negative scores if exposure is performed on young patients and osteoarthritic phenomena are not visible, so the operator relies only on signs of subluxation as indicators of the severity of the condition (Soo and Worth, 2015).

Among knee conditions related to hip dysplasia, the most commonly reported are patellar luxation, partial cranial cruciate ligament rupture, and osteoarthritic changes. A study conducted on 65 dogs found concurrent hip dysplasia and patellar luxation in 28% of cases (Kalff, 2014).

Clinical goniometry is an objective and non-invasive method of measuring joint angles, allowing for the assessment of the normal range of joint movements (Petazzoni, Jaeger, 2008). This method is among the standard orthopedic examination techniques that help indicate the severity of joint pathology (Petazzoni, Jaeger, 2008). Currently, goniometry is often used in the field of imaging and is a fundamental element in assessing the musculoskeletal system.

The aim of this work is to evaluate the effectiveness of goniometric measurements at the knee and hip joint levels in the exposure used in the radiological diagnosis of hip dysplasia.

Materials and methods

The biological material consisted of 41 medium and large-sized dogs of different ages and sexes who presented themselves to the Department of Medical Imaging within USAMV Clu-Napoca with the purpose of being radiologically evaluated at the hip joint level. Among these dogs, some showed symptoms representative of hip dysplasia, while others were asymptomatic. Out of a total of 41 cases, 10 cases considered the most relevant to the topic were selected and analyzed. All selected dogs were radiologically diagnosed with hip dysplasia. The individuals included in the study were aged between 7 months and 3 years, and weighed between 20 kg and 52 kg. Auxiliary materials used were: X-ray machine, plastic restraint support and radiological positioning bags, Horos software program

The work protocol for all canine patients included in the study was the same: performing a radiological exposure in a ventrodorsal position with the hind limbs extended caudally, and the knee joints rotated inward so that the patella is centrally positioned on the limb (Morgan, Wind, Davidson, 2000). Some of the patients were placed in the veterinary plastic support that facilitates the correct position for evaluating the hip joint. The images were made so that the knee joint could also be studied. Measurements made were:

- Norberg angle: to evaluate the degree of hip dysplasia
- Goniometric measurements made on the femur in the frontal plane, based on the anatomical and mechanical axis of the limb: aLPFA (lateral-proximal anatomical femoral angle), mLDFA (lateral-distal anatomical femoral angle), mLPFA (lateral-proximal mechanical femoral angle), and mLDFA (lateral-distal mechanical femoral angle) (fig. 1).

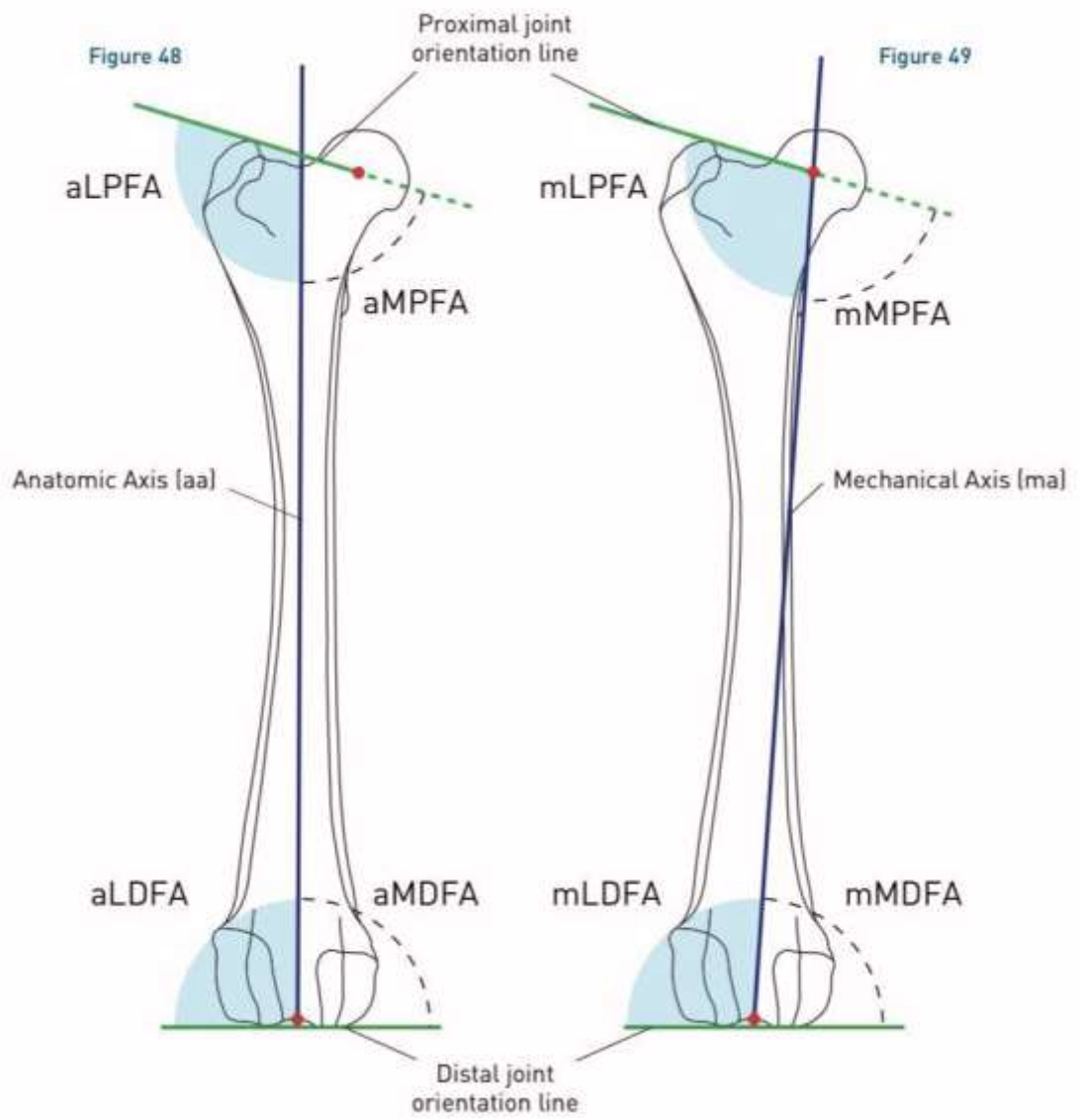


Fig. 1 Measuring methods for aLPFA, aLDFA, mLPFA, mLDFA

Petazzoni, Jaeger, Atlas of Clinical Goniometry and Radiographic Measurements of the Canine Pelvic Limb, 2008

Discussion

All determinations were made within the Horos program, a digital imaging program that allows the study of radiographs and the making of exact measurements. Auxiliary data about patients were obtained from the owners. All patients were part of the clinical cases present in our department (fig.2, fig. 3, fig. 4) and the written consent of the owners was obtained for each dog. Norberg and femoral angles were measured within the local DICOM viewer, and the statistical analysis was performed with IBM SPSS Statistics.

The statistical analysis follows the descriptive statistics of the obtained datas and the correlation between the Norberg angle and the values obtained for aLPFA/LDFA and mLPFA/LDFA for the examined patients.

The heatmap provides a visual representation of the strength and direction of the correlations. Positive values indicate a positive correlation, while negative values indicate a negative correlation.

Fig. 2 Ventrodorsally exposure and Norberg angle measurements

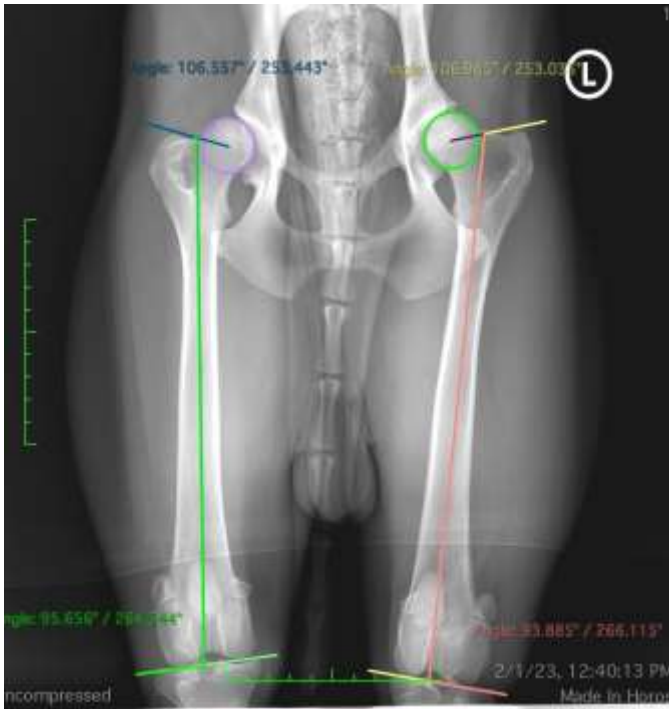


Fig. 3 Ventrodorsally exposure for aLPFA and aLDFA measurements

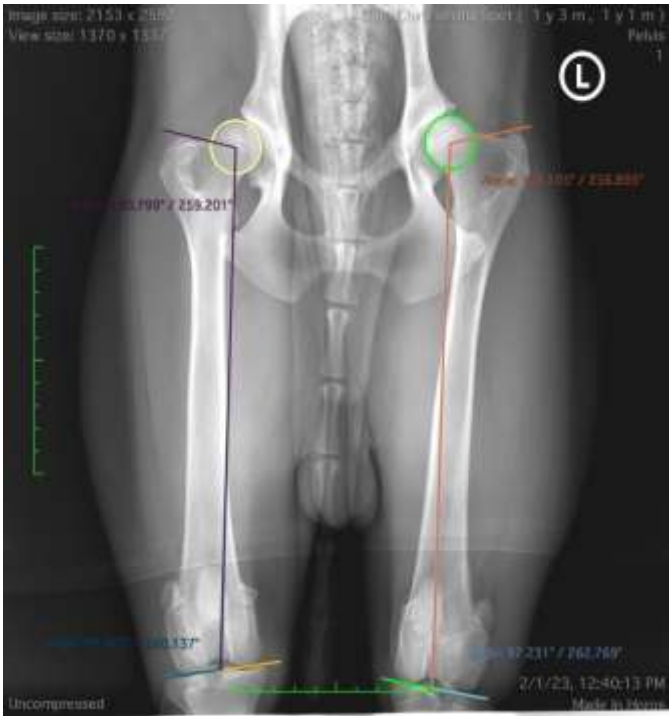
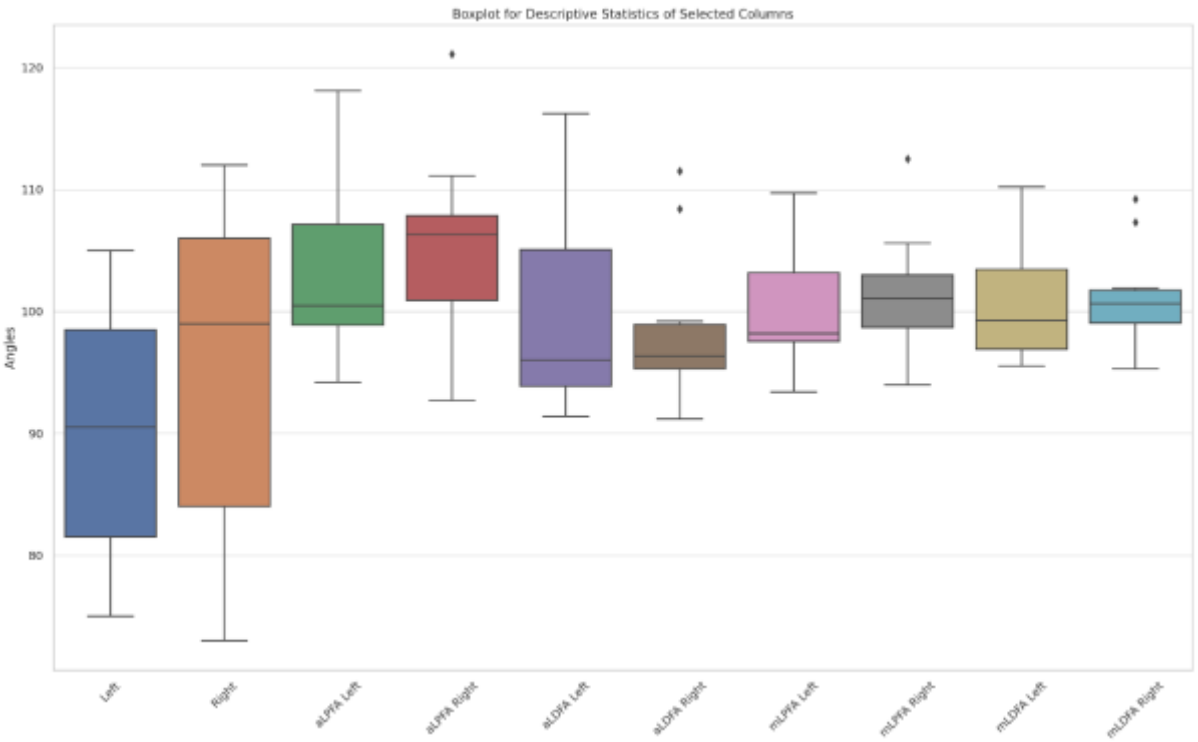


Fig. 4 Ventrodorsally exposure for mLPFA and mLDFA measurements



The central line in each box indicates the median.
The edges of the box indicate the interquartile range (IQR).
The whiskers extend to 1.5 * IQR.

Fig. 5 Boxplots for the Norberg angle and obtained measurements.

Table 1.

Descriptive statistics for the data's

Statistic	*Norberg Angle Left*	*Norberg Angle Right*	*aLPFA Left*	*aLPFA Right*	*aLDFA Left*	*aLDFA Right*	*mLPFA Left*	*mLPFA Right*	*mLDFA Left*	*mLDFA Right*
Mean	90.0	95.6	103.05	105.1	99.49	98.62	100.55	101.12	100.43	101.24
Std Dev	11.06	13.81	6.93	8.01	8.11	6.39	5.39	5.41	4.67	4.2
Min	75.0	73.0	94.2	92.7	91.4	91.2	93.4	94.0	95.5	95.3
25th Percentile	81.5	84.0	98.88	100.9	93.88	95.3	97.53	98.7	96.9	99.05
50th Percentile	90.5	99.0	100.45	106.3	96.0	96.35	98.2	101.05	99.25	100.65
Max	105.0	112.0	118.1	121.1	116.2	111.5	109.7	112.5	110.2	109.2

The Norberg angle for the right leg shows moderate to strong negative correlations with aLPFA Right and mLPFA Right.

The Norberg angle for the left leg does not exhibit strong correlations with any of the other angles, which suggests it may not be a good predictor based on these variables.

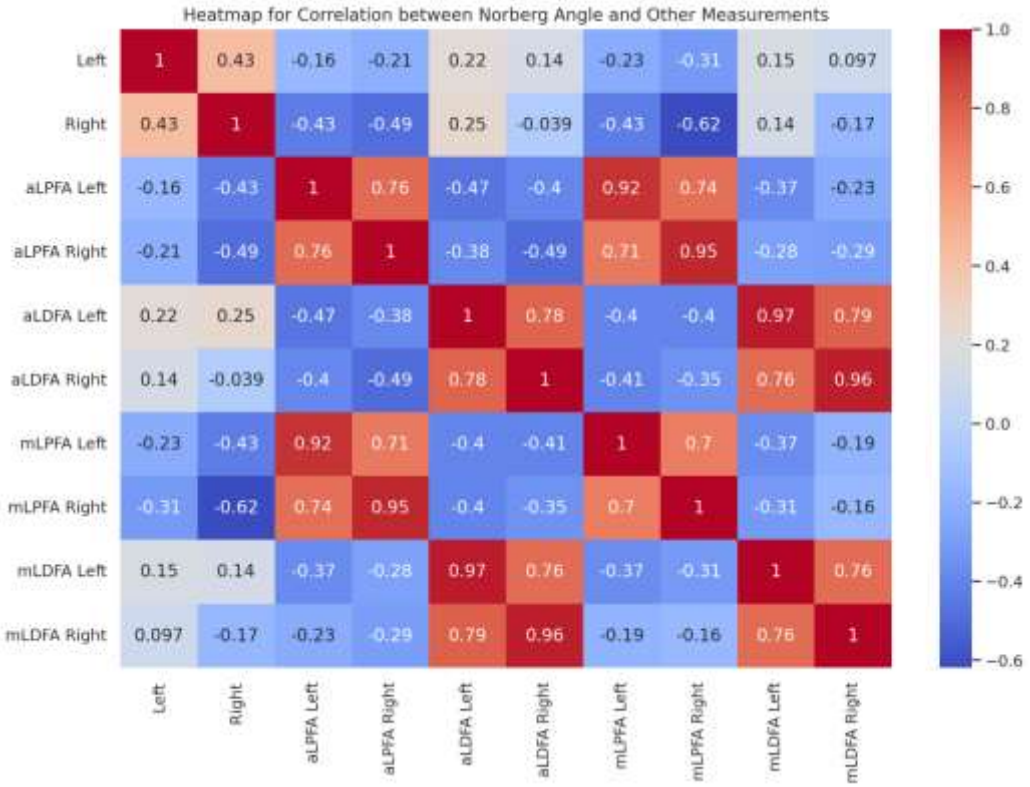


Fig. 6 Heatmap for correlation between Norberg angle and other measurements

Conclusions

In medical diagnostics, radiological examinations or other imaging techniques are essential for evaluating the normal appearance of hip and knee joints and for definitively diagnosing hip dysplasia. It is generally recommended that patients be sedated to ensure accurate positioning and yield the most relevant images. Goniometric measurements of aLPFA, aLDFA, mLPFA, and mLDFA obtained from conforming hip evaluations present a moderate level of relevance for assessing the normal alignment of the femur and adjacent joints. The study found no directly proportional relationship between the degree of hip dysplasia and the values of aLPFA, aLDFA, mLPFA, and mLDFA. It is also noted that dysplasia in one limb could potentially affect the alignment of the corresponding limb. Significant differences between the standard values proposed by different studies pose challenges in evaluating the normal frontal-plane alignment of the femur. Furthermore, breed-specific morphological and anatomical differences also influence the angles of aLPFA, aLDFA, mLPFA, and mLDFA. Other conditions that may or may not be correlated with coxofemoral dysplasia, such as patellar luxation, likewise affect these angle values. Finally, the study recommends further investigation of a statistically more representative sample concerning both the standard values of aLPFA, aLDFA, mLPFA, and mLDFA, as well as their variations in patients with coxofemoral dysplasia.

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