USING AUTOCAD 2007 FOR MEASUREMENT OF THE NORBERG ANGLE AND ACETABULAR COVERAGE PERCENTAGE IN DOGS

UTILIZAÇÃO DO AUTOCAD 2007 PARA MENSURAÇÃO DO ÂNGULO DE NORBERG E DA PORCENTAGEM DE COBERTURA ACETABULAR EM CÃES

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SUMMARY

The aim of this study was to evaluate the use of the AutoCAD 2007 software for quantitative evaluations of the Norberg angle (NA) and acetabular coverage percentage (ACP). The measurements were performed in x-rays of eight adult dogs aged between two and five years old, six mutt (non-purebred) dogs and two German Shepherds, weighing between 16.5 kg and 32 kg. Two methods of radiographic evaluation were used: Norberg angle and acetabular coverage percentage. The dogs were anesthetized with levomepromazine administered intramuscularly (1 mg/kg), with total dose up to 25 mg/animal and, after 15 minutes, propofol was administered (5 mg/kg) intravenously. Subsequently, the dogs were placed in the supine position, as recommended by the Orthopedic Foundation for Animals (OFA), for the x-rays. These images were then scanned and exported to the AutoCAD 2007 software in order to perform the measurements. Using this evaluation method it was possible to get the quantitative values of the Norberg angle and acetabular coverage percentage. AutoCAD 2007 proved to be efficient, accurate and easy to use in order to determine the values of these two parameters.

KEY-WORDS: Dogs. Evaluation. Hip dysplasia.

RESUMO

O objetivo é avaliar o uso do programa AutoCAD 2007 para avaliações quantitativas referentes ao ângulo de Norberg (AN) e porcentagem de cobertura acetabular (PCA). A demonstração da utilização do AutoCAD 2007 foi feita em oito cães adultos, com idade variando entre dois a cinco anos, seis sem raça definida e dois pastores alemães, peso entre 16,5 a 32 kg. Foram empregados dois métodos de avaliação radiográfica: o ângulo de Norberg e a porcentagem de cobertura acetabular. Os cães foram anesthesiados com levomepromazina (1 mg/kg) não ultrapassando a dose total de 25 mg por animal, por via intramuscular e após 15 minutos foi administrado propofol (5 mg/kg) por via intravenosa. Utilizou-se o posicionamento em decúbito dorsal, preconizado pela Fundação de Ortopedia para Animais (OFA) e, após obtenção das radiografias, as imagens foram digitalizadas e exportadas para o programa AutoCAD 2007 para as mensurações. Usando o método de avaliação proposto foi possível realizar as medidas quantitativas relativas ao ângulo de Norberg e porcentagem de cobertura acetabular. O AutoCAD 2007 mostrou-se eficiente, preciso e de fácil utilização na obtenção dos valores relativos aos métodos preconizados.

PALAVRAS-CHAVE: Cães. Diagnóstico. Displasia coxofemoral.

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INTRODUCTION

The canine hip dysplasia (CHD) is a hereditary disease (CORLEY, 1992, BLISS et al., 2002), which is associated with environmental factors such as nutrition (EVERTS et al., 2000, CARNEIRO et al., 2006), physical activity (SALLANDER et al., 2006) and abnormal pelvic musculature (CARDINET et al., 1997). High body weight at birth and rapid growth (Van HAGEN et al., 2005) may cause varying degrees of pain and osteoarthritis. It is common in large breed dogs characterized by joint laxity and subluxation of the femoral head (LUST, 1997). It is frequently diagnosed during routine examination in the veterinary clinic and commonly associated with dogs (SMITH, 1997). Since the evaluation is often performed before 24 months of age, there is a large number of false negatives (KAPATKIN et al., 2002). The conventional and distraction radiographic methods associated improve the efficiency of the diagnosis (TÔRRES et al., 2005).

In Brazil, the routine evaluation method used especially by the Brazilian College of Radiology measures the Norberg angle (NA) while verifying the presence of degenerative joint disease. This quantitative method assesses joint laxity (LANGENBACH et al., 1998) and acetabular coverage percentage (ACP) as well. The Norberg angle measures the subluxation of the femoral head, while acetabular coverage percentage (ACP) evaluates the percentage of acetabular coverage of the femoral head (TOMLINSON & JOHNSON, 2000). The ACP measurement can be performed based on a line running from the fovea to the greater trochanter. The ratio between the distances from the fovea to the acetabular margin and from the fovea to the physis of the femoral head multiplied by 100 (RASMUSSEN et al., 1998) gives the percentage of acetabular coverage.

The Norberg angle is an important classification criteria used to evaluate the joint laxity and acetabular depth (GENEVOIS et al., 2007), which when determined at an early age may help to detect hip subluxation in adulthood (KEALY et al., 1993). Approximately half of the animals considered healthy, display signs of CHD later in life. However, this technique is not suitable to be used in very young animals (14 to 22 weeks), since the skull-lateral edge of the acetabulum is still cartilaginous and does not provide accurate measurements (VEZZONI et al., 2008). Previous study of the *Orthopedic Foundation for Animal* (OFA) reported 89% reliability on preliminary assessment from 4 to 23 months (CORLEY, 1992). Moreover, poor positioning of the dog is the most common cause of incorrect angle measurement, which is minimized when performed by experienced veterinarians (GENEVOIS et al., 2007). The NA is the angle formed by a line connecting the centers of both femoral heads and another one drawn between the center of a femoral head and the craniodorsal rim of the acetabulum on the same side, these lines are drawn on radiographic images of the standard ventrodorsal position. If the angle is equal or greater than 105° the dog does not suffer of CHD, while for values smaller than 105° the dogs are dysplastic. The center of the femoral head is determined using transparent circles of various sizes as well as software such as Corel Draw (NOGUEIRA et al., 2005), and the quantitative measurements are performed by Sigma Scan, Jandel Scientific (TOMLINSON & JOHNSON, 2000), Canvas 6.0.1 (TOMLINSON & COOK, 2002), Adobe Photoshop 5.5 (LOPEZ et al., 2008) and last, with little use in veterinary so far, the autoCAD 2007 (REGONATO et al., 2009).

With the latest technological advances and the remarkable popularity of the digital camera, the autoCAD combined with measurements performed by computer programs has been used routinely in research. AutoCAD is a software that was originally developed for engineering and has been widely used in medicine (ALMEIDA et al.,2007), dentistry (GOIATO et al., 2005) and physiotherapy (SATO, 2003). According to Castelo Branco Neto et al. (2006) the program is effective in assessing uneven surface areas, allow revisions and it is easy to use.

Therefore, the objective of this study is to describe the use of the AutoCAD 2007 program to measure the Norberg angle and to determine the percentage of acetabular coverage.

MATERIAL AND METHODS

The study used eight adult dogs, six mutt dogs and two German Shepherds, aged between 2 and 5 years old, weighing between 16.5 and 32 kg. The standardization of the breeds was not possible as the animals came from the Zoonoses Control Center. During the sampling, some animals were excluded due to infectious diseases, aggressive behavior, clinical or radiographic changes that prevented them from being included in the sample.

The study was conducted according to the Ethical Principles in Animal Experimentation, adopted by the Brazilian College of Trial (Colégio Brasileiro de Experimentação, COBEA) and approved by the Animal Ethics and Welfare Committee (Comissão de Ética e Bem Estar Animal, CEBEA) under protocol n° 026276-08, at the Faculdade de Ciências Agrárias e Veterinárias, UNESP, Jaboticabal, SP.

The standard ventrodorsal positioning as defined by the Orthopaedic Foundation for Animals (OFA) was adopted. The dogs were positioned supine, with extended limbs, parallel to each other and to the spine, the knee was kept medially rotated, so that the patella overlapped the trochlear groove. The pelvis was kept in the horizontal position. Before the X- rays, the dogs were anesthetized intramuscularly with levomepromazine (1 mg/kg), with a total dose up to 25 mg/animal and, after 15 minutes propofol was administered (5 mg/kg) intravenously.

The radiographs were made using a Raicenter X-ray equipment on the table, model RC600 plus, radiographic films 30 x 40 (Kodak MXG 30x40),

mounted on a metal chassis (Metaltronica 30x40) with intensifying screens (Kodak Lanex®). The appropriate radiographic technique was adopted for each dog. The radiographic films were identified with bright marker (Metaltronica) and processed automatically (Macrotec MX-2). A total of 40 radiographs were obtained at different evaluation times, since each animal underwent surgery for acetabular ventroversion.

We used two methods of radiographic evaluation: the Norberg angle (NA) and the acetabular coverage percentage (ACP). The percentage of acetabular coverage is given by the following formula: **(a : b) X 100 = %** of acetabular coverage, where (**a**) is the area the femoral head covered by the acetabulum and (**b**) is the total area of the same femoral head. The radiographs were scanned using a digital camera (Sony DSC-H50, 9.1 megapixel) and the images were then used to perform the measurements using the software AutoCAD® 2007 (Autodesk – San Rafael, USA). The measurements were made by the same person at all times.

RESULTS

The digital methods to measure the Norberg angle are represented on the images captured by the software AutoCAD® 2007 (figures 1 to 4). Each step has been detailed for better visualization and understanding.

Therefore, each picture depicts the tools used (red circle - column to the left and/or line above the image) to draw the lines used to measure the parameters in both methods. In the following figures (5 to 7) are represented the digital methods used to measure the percentage of acetabular coverage.

DISCUSSION

Accurate diagnosis is important to understand the true prevalence of the disease and its genetic control. However, early detection is essential even before clinical and radiographic signs appear (KAPTKIN et al., 2002). These authors consider the evidence of joint laxity and degenerative joint disease important for diagnosis.

There is a lot of discussion about the validity of using the Norberg angle for early diagnosis of hip dysplasia (VEZZONI et al, 2008), but Corley (1992) reported 89% reliability on preliminary assessment form 4 to 24 months. Given these facts, the use of evaluation methods aided by computer programs such as autoCAD tend to increase reliability. It should be noted that badly positioned radiographic images were discarded to minimize incorrect measurements, similar to what has been reported by Genevois et al. (2007).
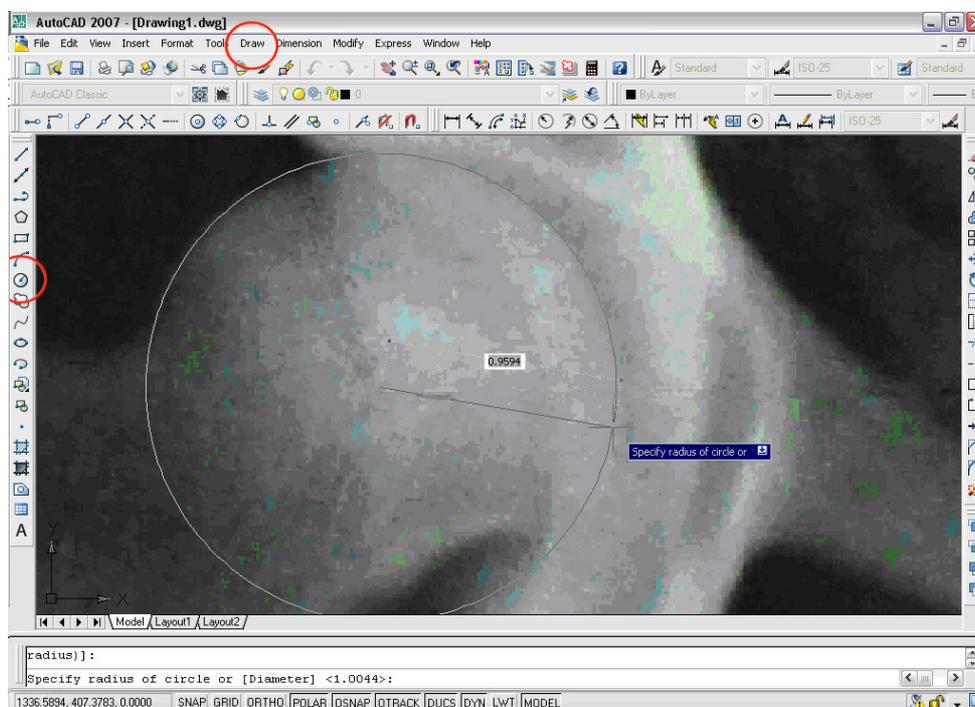

Figure 1 - Digital method for measuring the Norberg angle. After transferring the image, we used the zoom tool from the software to help visualize the most important structures. Subsequently, the femoral head is marked using the circle tool and the center is determined. The same steps are repeated on the contralateral femoral head. A reference point previously marked on the X-ray was adjusted to the standard measurements of the software, so the measurements are equivalent.
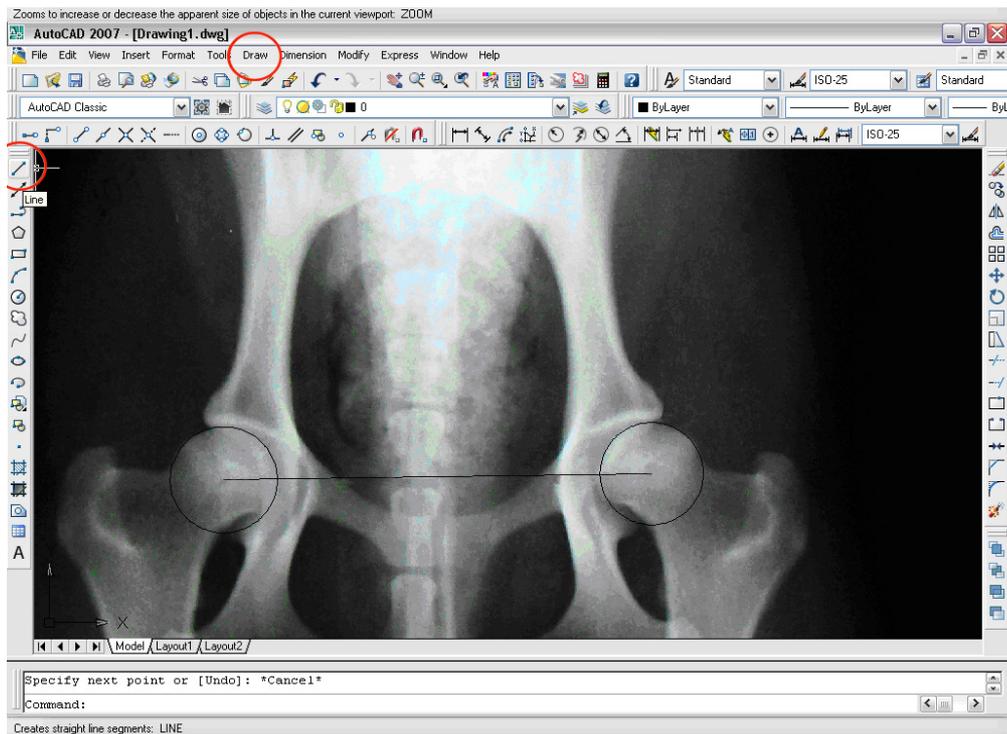
Figure 2 - Digital method for measuring the Norberg angle. After determining the center of the femoral heads, both centers are united by drawing a line using the line tool.
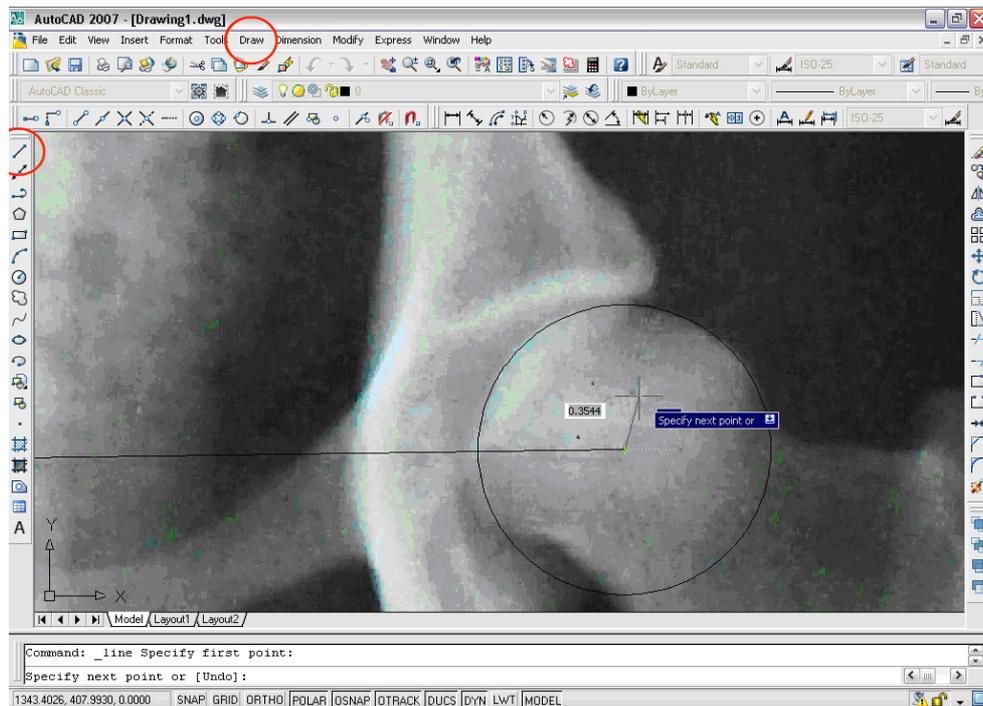

Figure 3 – Digital method for measuring the Norberg angle. Another line is drawn between the center of the femoral heard and the craniodorsal acetabular rim, also using the line tool.
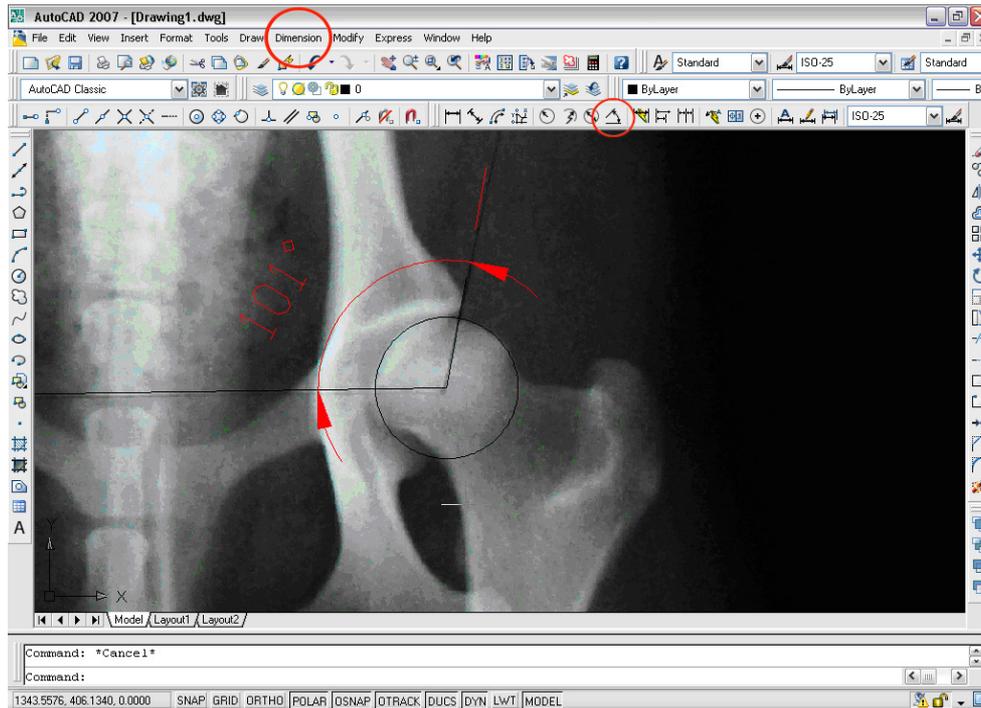
Figure 4 - Digital method for measuring the Norberg angle. Now the angle formed by the two lines is measured by the AutoCAD ® program using the tool dimension – angular.
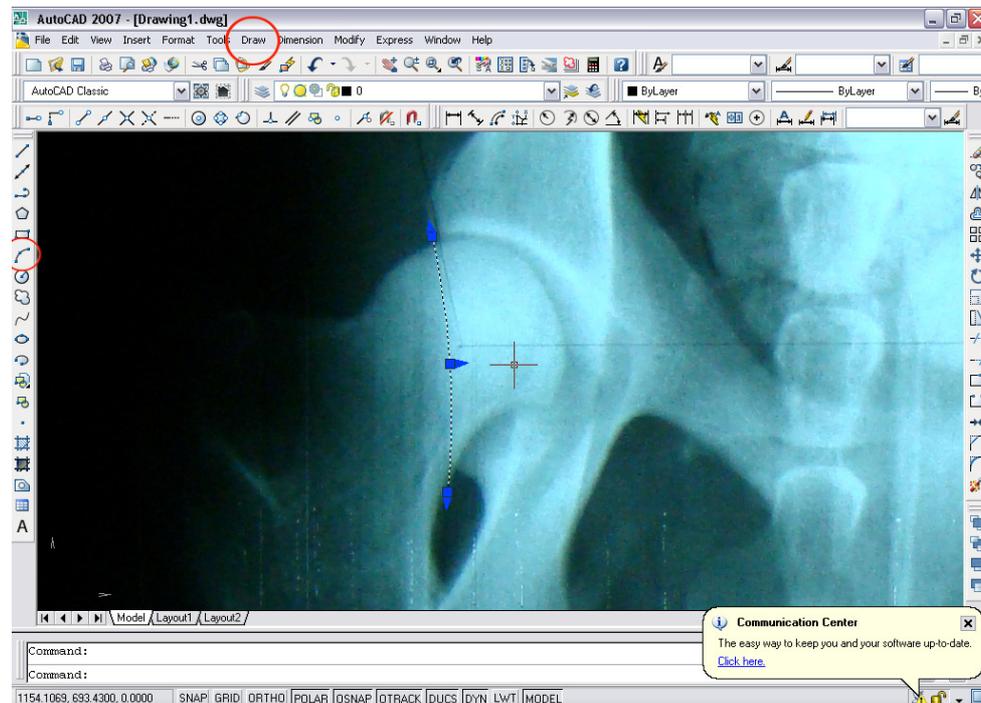

Figure 5 - Digital method for measuring acetabular coverage percentage. After transferring the file, the zoom tool is used to help improve visualization. Then, a line is drawn on the acetabular rim by selecting the option draw, followed by arc and then three points.
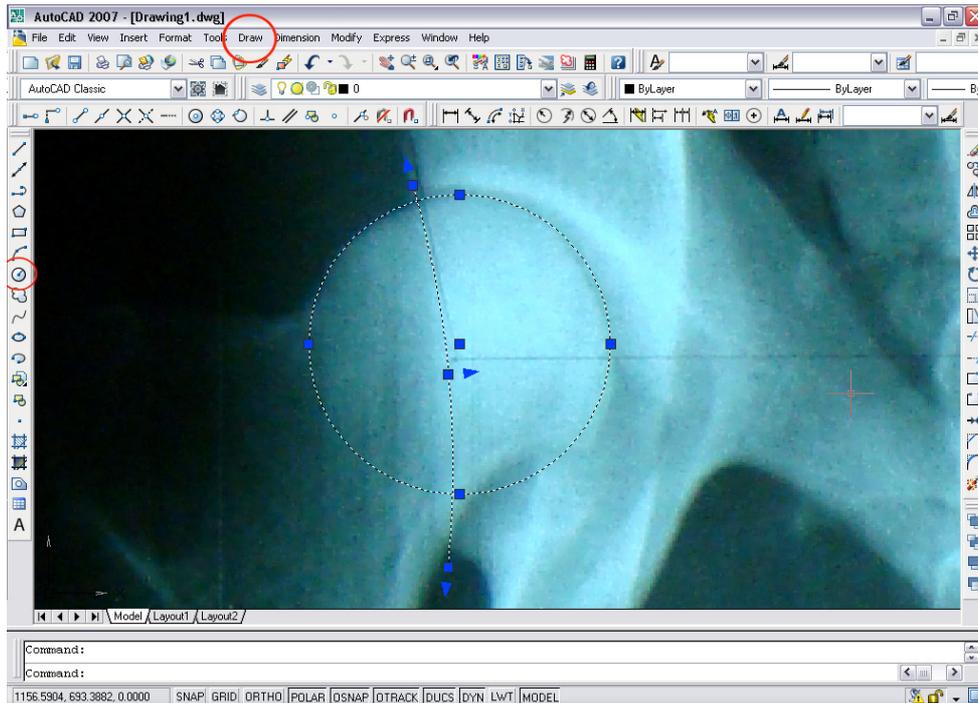
Figure 6 - Digital method for measuring acetabular coverage percentage. We used the circle tool to draw a circle around the femoral head.
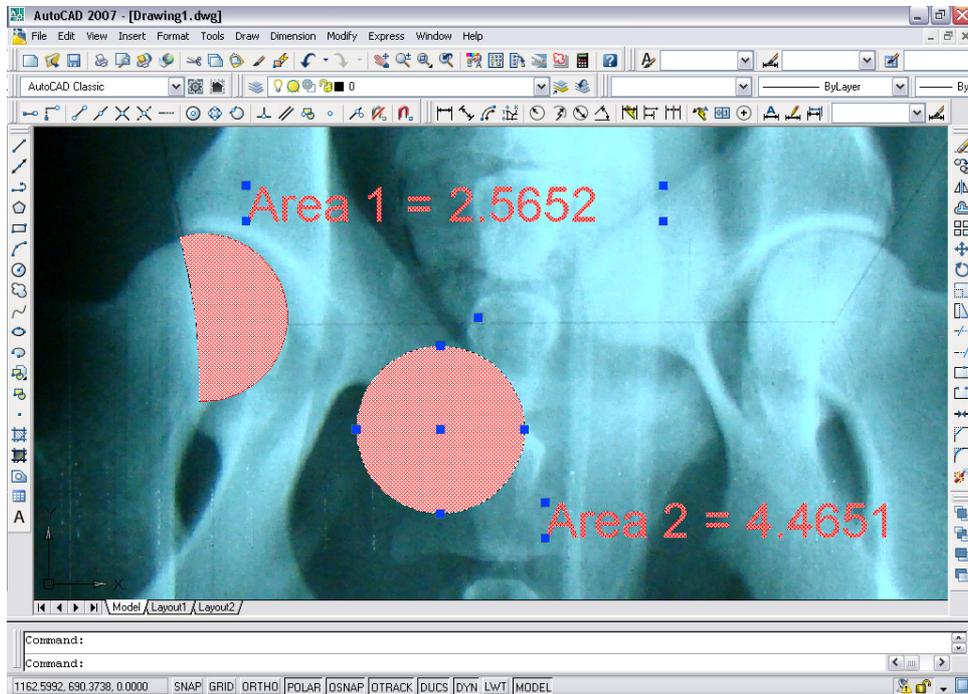

Figure 7 - Digital method for measuring acetabular coverage percentage. We used the option draw followed by hatch to fill up the circle around the femoral head (total area). This was followed by the options modify and properties to calculate the area of the femoral head. The same procedure was repeated to determine the area of the femoral head that was covered by the acetabulum (area 1) and total area (area 2). The area 1/ area 2 ratio times 100 gives the percentage of acetabular coverage.

According to Tomlinson & Johnson (2000), the bevel edge of the acetabular rim gives small values of ACP and the prominent craniodorsal rim affects NA measurements. Using autoCAD it was possible to outline point by point the acetabular rim and to draw precise lines on the craniodorsal rim, using the zoom tool to minimize the deviations, thus resulting in more accurate values. It is also possible to detect more accurately degenerative injuries. This corroborates Smith (1997), who mentioned the presence of joint laxity, DAD or both in the diagnosis of CHD.

The use of AutoCAD 2007 to determine ACP may provide more accurate values compared to the method used by Rasmussen et al. (1998); however, further studies are being conducted. Other programs have been used for measuring the values of NA and ACP (TOMLINSON & JOHNSON, 2000; TOMLINSON & COOK, 2002; LOPEZ et al., 2008), but the method described here is a new tool to assess joint laxity. Similar to what has been stated by Wendt (2007), this program was effective and versatile during the measurements and could be better publicized in research related to veterinary medicine.

CONCLUSION

AutoCAD® is an alternative tool to obtain measurements of the Norberg angle and acetabular coverage percentage. It is easy to use and provides great accuracy to trace the lines that are necessary to perform the measurements on digitized radiographic images. Studies are being conducted to ascertain the reliability and repeatability of the method compared to other evaluation methods.

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