ESCOLA UNIVERSITÁRIA VASCO DA GAMA

MESTRADO INTEGRADO EM MEDICINA VETERINÁRIA

Dorsal Acetabular Rim Arthroplasty for the management of canine hip dysplasia: a case report

Florence Leleu

Coimbra, julho de 2022

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Abbreviations

º – Degree

ºC – Degree Celsius

% - Percent

µg – Microgram

AIS – Antech Imaging Services

BID – *Bis In Die* (Twice a day)

BPM – Beats per minute

CHD – Canine hip dysplasia

cm – Centimeters

CT – Computed tomography

DAR – Dorsal acetabular rim

DI – Distraction index

FCI – International Cynological Federation

h - Hour

IV – Intravenous

kg – Kilogram

mAbs – Monoclonal antibodies

mg – Milligram

ml – Milliliter

mm – Millimeter

NGF – Nerve growth factor

NSAIDs – Non-steroidal anti-inflammatory drugs

OA – Osteoarthritis

OFA – Orthopedic Foundation for Animals

PO – Per os

RA – Reduction angle

SA – Subluxation angle

SC – Subcutaneous

SID – *Semel In Die* (Once daily)

USP – United States Pharmacopeia

TID – *Ter In Die* (Three times a day)

Dorsal Acetabular Rim Arthroplasty for the management of canine hip dysplasia: a case report

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RESUMO

A displasia da anca é uma das doenças ortopédicas mais comuns nos cães domésticos. É uma doença de desenvolvimento, poligénica e multifatorial que se caracteriza pelo aparecimento durante o período de crescimento de lassidão articular, subluxação, e artrose da anca. Os cães afetados podem manifestar claudicação e dor crónica causadas pela degeneração e progressão da osteoartrite na articulação da anca. Os cães nascem com as ancas normais, mas nos animais com displasia, as alterações da anca causam desconforto e sinais clínicos com maior frequência entre os 4 e os 8 meses de idade. A dor associada à lassidão articular pode diminuir devido à fibrose periarticular e ao espessamento da cápsula articular que estabiliza a articulação. Na idade adulta os sinais clínicos podem agravar devido à evolução da osteoartrite. Embora a lassidão articular predisponha ao desenvolvimento de osteoartrite, a relação entre o grau de lassidão e de osteoartrite varia entre raças. A apresentação clínica dos cães com displasia da anca é muito variável, alguns cães são assintomáticos, noutros casos pode haver uma claudicação ligeira, ou graus mais intensos de dor e claudicação. Nos casos mais graves pode haver uma diminuição marcada da qualidade de vida.

O objetivo no maneio da displasia da anca é prevenir o desenvolvimento de osteoartrite, eliminar a dor e devolver uma função normal o membro pélvico, recorrendo a um diagnóstico precoce e instituindo um tratamento médico ou cirúrgico. Existem várias opções cirúrgicas para tratar cães com displasia da anca, mas a sua indicação depende da idade do paciente, da severidade da doença, das alterações radiográficas, do comportamento animal, da presença de outras doenças e dos recursos financeiros disponíveis.

Este estudo de caso pretende relatar o procedimento cirúrgico de artroplastia do rebordo acetabular dorsal para o tratamento de um cão jovem de 5 meses de idade, com risco elevado de desenvolver displasia da anca, na fase inicial do desenvolvimento da osteoartrite. Na literatura científica, a artroplastia do bordo acetabular dorsal é descrita como uma cirurgia paliativa que se pode usar nos cães que não são candidatos a osteotomia pélvica, no entanto, o seu uso clínico é raro, havendo poucos casos relatados. A falta de estudos que avaliem os seus resultados clínicos são um dos principais entraves à divulgação e utilização mais frequente desta técnica. Neste sentido, este estudo procura incentivar o interesse da comunidade científica neste procedimento.

A dissertação fornecerá uma descrição do procedimento cirúrgico, dos resultados deste tratamento obtidos por avaliações clínicas, imagens radiográficas, tomográficas e artroscópicas. Por fim, serão descritas as vantagens e desvantagens da artroplastia do rebordo acetabular dorsal nos cães com risco elevado de sofrer osteoartrite secundária à displasia da anca.

PALAVRAS-CHAVES

Displasia da anca, bordo acetabular dorsal, artroplastia, osteoartrite

ABSTRACT

Hip dysplasia is one of the most common orthopedic diseases in domestic dogs. It is a developmental, polygenic and multifactorial disease that is characterized by its appearance during the growth period of joint laxity, subluxation, and arthrosis of the hip. Affected dogs may manifest lameness and chronic pain caused by degeneration and progression of osteoarthritis in the hip joint. Dogs are born with normal hips, but in animals with dysplasia, hip changes cause discomfort and clinical signs frequently between 4 and 8 months of age. The pain associated with joint laxity may decrease due to periarticular fibrosis and the thickening of the joint capsule that stabilizes the joint. In adulthood clinical signs can worsen due to the evolution of osteoarthritis. Although joint laxity predisposes to the development of osteoarthritis, the relationship between the degree of laxity and osteoarthritis varies between races. The clinical presentation of dogs with hip dysplasia is very variable, some dogs are asymptomatic, but in other cases there may be a slight claudication, or more intense degrees of pain and lameness. In the most severe cases there may be a marked decrease in life quality.

For managing hip dysplasia, the objective is to prevent the development of osteoarthritis, eliminate pain and return a normal function of the pelvic limb, by using an early diagnosis and instituting a medical or surgical treatment. There are several surgical options for treating dogs with hip dysplasia, but their indication depends on the age of the patient, the severity of the disease, radiographic changes, animal behavior, the presence of other diseases and the available financial resources.

This case study aims to report the surgical procedure of the dorsal acetabular rim arthroplasty for the treatment of a young dog of 5 months of age, with high risk of developing hip dysplasia, in the initial phase of the development of osteoarthritis. In scientific literature, dorsal acetabular rim arthroplasty is described as a palliative surgery that can be used in dogs that are not candidates for pelvic osteotomy, however, its clinical use is rare, with few cases reported. The lack of studies evaluating their clinical results is one of the main obstacles to the divulgation and more frequent use of this technique. In this sense, this study seeks to encourage the interest of the scientific community in this procedure.

The dissertation will provide a description of the surgical procedure, the results of this treatment obtained by clinical evaluations, radiographic, tomographic and arthroscopic images. Finally, it will be described the advantages and disadvantages of dorsal acetabular rim arthroplasty in dogs with high risk of suffering osteoarthritis secondary to hip dysplasia.

KEY WORDS

Canine hip dysplasia, dorsal acetabular rim, arthroplasty, osteoarthritis

1. INTRODUCTION

Canine hip dysplasia (CHD) can occur within different breed types and sizes of dogs but is mainly seen in large dogs, dogs with a high length-to-height ratio, and brachycephalic dogs (Schachner & Lopez, 2015). The understanding of the disease's etiology has not been completely cleared yet, and it is assumed that CHD occurs from interactions of multiple genes and environmental influences (Janutta & Distl, 2006). The Orthopedic Foundation for Animals (OFA) shares an estimated value of CHD's prevalence in dogs that varies from 0 to 71,2% based on breed (OFA website).

Overall, CHD can be described as a complex developmental disease that involves joint laxity, degeneration, and osteoarthritis (OA) on the hip (Schachner & Lopez, 2015). The primary risk factor to consider is hip joint laxity. That laxity causes instability of the hip that could be the origin of OA development (Remedios & Fries, 1995). The clinical signs of hip dysplasia include reluctance to exercise, gait abnormalities, hind limb lameness, and muscle atrophy (Fry & Clark, 1992).

Multiple lesions can be observed depending on the patient's age. The developmental abnormalities that are investigated in CHD include synovial inflammation, articular cartilage damage, formation of osteophytes, subchondral bone sclerosis, and remodeling of the coxofemoral joint. It may also be observed subluxation of the femoral head, a delay in ossification of the cranial and dorsal acetabular rims, articular cartilage degeneration, microfractures, thickening, inflammation, and deterioration of the joint capsule, tendinous insertions, and ligaments of the hip when the patient is old (Schachner & Lopez, 2015).

CHD is described as a pre-osteoarthritic disorder (Pascual-Garrido et al., 2018), meaning that the purpose of therapy is to prevent the progression of OA. Subsequently, early screening and treatment of the disease are crucial (Kotlarsky et al., 2015). Diagnosis of CHD must include a physical examination that contains specific manipulations, the Ortolani, the Barlow, and the Barden tests (Fry & Clark, 1992), with the purpose of evaluate the joint laxity on the hip (Vidoni et al., 2021). The previous tests are performed under anaesthesia or deep sedation (Vezzoni, 2004). An orthopedic and neurological examination is suggested prior to radiographic examinations (Fry & Clark, 1992). Goniometric measurements consist in estimating the reduction angle (RA) and the subluxation angle (SA) to measure the coxofemoral alignments (Vidoni et al., 2021) and obtaining reference values. The RA is calculated with an Ortolani test and corresponds to the maximum inclination of the femur in relation to the sagittal plan until the reduction of the hip occurs. Measured in a Barlow test, the SA corresponds to the inclination between the femur and the sagittal plane. Increased SA correlates to further inclination of the dorsal acetabular rim (DAR), or DAR slope, acetabular filling with osteophytes, and round ligament thickening that reduce the acetabular space (Vezzoni, 2004).

These measurements are interpreted to establish a prognosis for CHD development, along with the position of the femoral head in relation to the DAR and the distraction index, as described in Table 1.

PROGNOSIS	ORTOLANI SIGN	ANGLE OF REDUCTION	ANGLE OF SUBLUXATION	CENTRE OF FEMORAL HEAD	DISTRACTION INDEX	DAR SLOPE
NORMAL HIPS	Negative	_	_	Medial to DAR	0,2 – 0,4	< 6º
NEARLY NORMAL HIPS TO MILD CHD	Positive	20º - 30º	0º - 5º	Over the DAR	0,3 – 0,5	< 7,5º
MILD TO MODERATE CHD	Positive	30º - 40º	5º - 15º	1 - 2 mm lateral	0,4 – 0,6	8º - 10º
MODERATE TO SEVERE CHD	Positive	> 40º	> 15º	3 mm or more lateral	> 0,6	> 12º
VERY SEVERE CHD	Positive	> 40º (less with OA)	> 25º	3 mm or more lateral	> 0,8 (less with OA)	> 15º

Table 1 – Prognosis of CHD development according to early evaluation data obtained at four to six months of age (Adapted from Vezzoni, 2004)
(CHD: Canine hip dysplasia, OA: Osteoarthritis, DAR: Dorsal acetabular rim)

Five standardized evaluation systems classify dysplasia by the animal's radiographic joint conformation and degenerative changes. These evaluation systems are the Orthopedic Foundation for Animals, the British Veterinary Association/Kennel Club, the International Cynological Federation (FCI), the Pennsylvania Hip Improvement Program, and the Dorsolateral Subluxation (Smith et al., 2018). These radiographic exams are also performed under deep sedation or anaesthesia. The OFA radiographic evaluation classifies the extended hip by nine parameters (Figure 1A) as the BVA scoring (Figure 1B) (Schachner & Lopez, 2015).

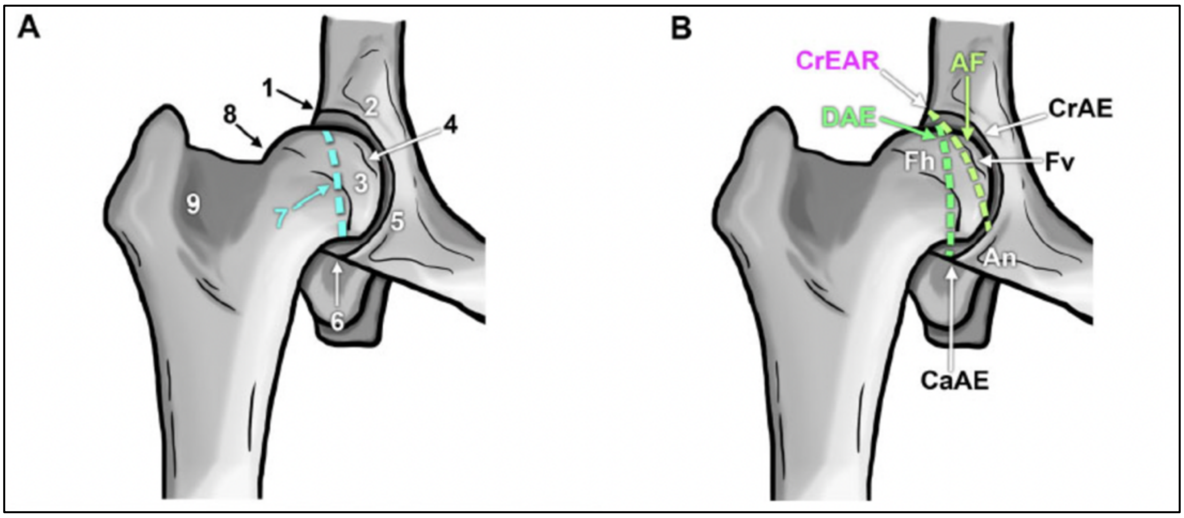

Figure 1 – Representations of anatomical landmarks to assess CHD (Adapted from Schachner & Lopez, 2015).

A Coxofemoral joint anatomical characteristics considered by the OFA: Craniolateral acetabular rim (1), cranial acetabular margin (2), femoral head (3), fovea capitis (4), acetabular notch (5), caudal acetabular margin (6), dorsal acetabular margin (7), junction of femoral head and neck (8) and trochanteric fossa (9)

B BVA/Kennel Club canine coxofemoral joint characteristics scored during evaluation: Acetabular Fossa (AF), Acetabular notch (An), Cranial Acetabular Edge (CrAE), Cranial Effective Acetabular Rim (CrEAR), Dorsal Acetabular Edge (DAE), Femoral head (Fh) and Foveal defect (Fv)

For the FCI radiographs, the first views should be done with extended hind limbs and the following views with abducted hind limbs (FCI website). Hips are scored from A, for normal hips, to E, for severe hip dysplasia, using as a criterion the Norberg angle (Figure 2) and other hip conformation parameters (Schachner & Lopez, 2015). The Norberg angle corresponds to the angle between the horizontal line that crosses the two femoral head centers and the line that crosses the examined femoral head center and the cranial acetabular edge (Dennis, 2012).

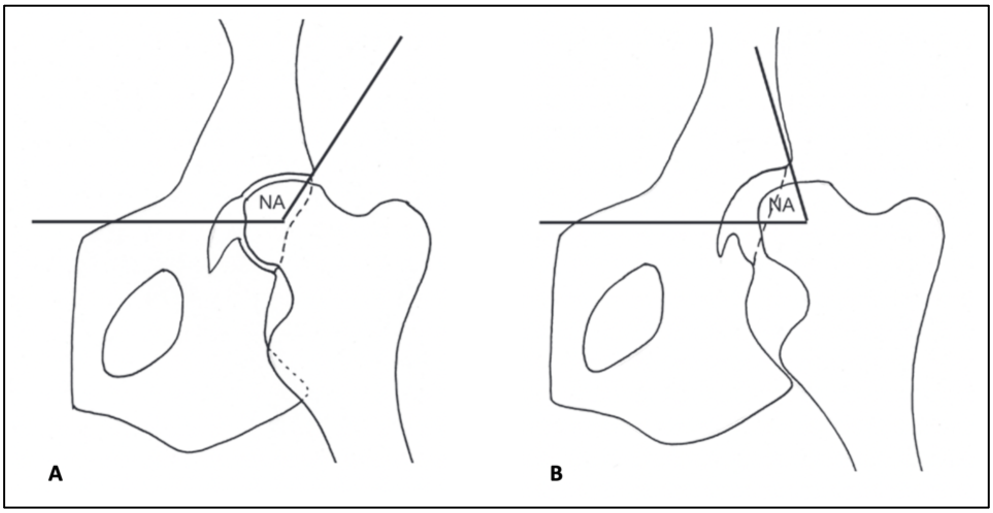

Figure 2 – Schematic representation of the Norberg angle on an extended hip (Adapted from Dennis, 2012)

A Non dysplastic hip with a NA superior to 105º

B Dysplastic hip with a NA inferior to 90º

NA Norberg angle

The Antech Imaging Services (AIS) PennHIP method uses three different radiographic views to evaluate the hip: a hip-extended view, a compression view, and a distraction view. To acquire the last radiographic view, a PennHIP distraction device is needed to obtain the maximum laxity the hip can reach. The distraction index (DI) is measured in the distraction view, resulting in a value between 0 and 1, 0 being the minimal femoral distraction. The DI corresponds to the distance the femoral head covers when displaced from the acetabulum (AIS website). The dorsolateral subluxation (DLS) score is determined by the femoral head coverage, meaning the percentage of the femoral head that is medial to the lateral edge of the acetabulum. If the score is under 45%, it is considered that the animal has a higher probability of developing OA, whereas a score superior to 55% is considered OA unsusceptible (Farese et al., 1998).

Radiographic imaging is considered the gold standard evaluation to quantify degenerative joint changes, however, as computed tomography (CT) technology rises, two-dimensional and three-dimensional CT imaging has become more popular for the purpose of CHD diagnosis (Schachner & Lopez, 2015). Magnetic resonance imaging is also used to observe articular soft tissues, however CT imaging is better to assess bones, so it has been more exploited to diagnose CHD and predict osteoarthritic changes (Schachner & Lopez, 2015).

Conservative management for CHD is considered a palliative treatment. The medical treatment aims to reduce the chronic pain caused by osteoarthritic changes, improve limb function, and slow degenerative processes. This multimodal approach includes nutritional, physical, and pharmacological therapy (Smith et al., 2018). Surgical therapy for CHD includes prophylactic, but also palliative and salvage surgical procedures (Vezzoni & Peck, 2018). Conservative and surgical therapies for CHD will be furtherly described in the discussion. The next section describes the case of a dorsal acetabular rim arthroplasty (DARthroplasty) in a 5-month-old dog with a high risk of developing hip dysplasia, and is followed by the clinical and surgical outcomes of this particular method. The surgical procedure described in this case report was performed by Dr. Frédéric Sanspoux, and is inspired by Dr. Rafael Lourenço's surgical technique for DARthroplasty.

2. CASE PRESENTATION

2.1. ANAMNESIS

A 5-month-old crossbreed male dog weighing 43 kg presented for bilateral hind limb lameness at the clinic. The animal also expressed trouble getting up in the morning and pain when manipulated on the hind limb region. In addition, the owner noticed that he had a bunny hopping walk. The animal had no history of clinical disease before this lameness, and his parents had not presented any sign of hip dysplasia during their life. The patient was vaccinated and dewormed internally and externally.

2.2. CLINICAL PRESENTATION

The animal exhibited a very agitated character, a 4/9 body condition score, a body temperature of 38,8ºC, a capillary refill time of lower than two seconds, pink mucous membranes, less than 5% of dehydration, and a heart rate of 68 BPM. No abnormalities were detected in the cardiopulmonary auscultation apart from a slight polypnea. A lameness on the hind limbs was confirmed, and muscle atrophy and pain were elicited by palpation of the hind limbs. The animal had reluctance to walk and exercise, and an audible "click" was heard during the walk.

The differential diagnosis for hind limb lameness includes a variety of bones and joints diseases (traumatic, infectious, inflammatory, degenerative, nutritional, and neoplastic causes), muscles diseases (traumatic, infectious, and inflammatory causes), and tendons and ligaments traumatic diseases (Thompson, 2014). In addition, neurological disorders and metabolic bone diseases are included in these differentials (Schachner & Lopez, 2015).

An orthopedic examination revealed a positive response to the Ortolani test on both sides. In the Ortolani test, the hip is placed in abduction with the animal in dorsal and lateral recumbency, and pressure is applied to the femur proximally to observe if a subluxation or luxation of the coxofemoral joint occurs and if the dislocated hip returns to a normal position in the acetabulum. The Ortolani sign is considered positive when a femoral head reduction is perceived (Ortolani, 1976). A clicking sound was heard during this test. The audibility of the sound should be considered to evaluate the severity of the joint luxation (Vidoni et al., 2021).

2.3. CLINICAL DIAGNOSIS AND IMAGING TESTS

The first radiographic assessment was conducted under general anaesthesia. The anesthetic protocol included medetomidine (11 µg/kg IV) and midazolam (0,2 mg/kg IV) as a premedication, propofol for the induction (1 mg/kg IV), and a mixture of isoflurane (1,5%) in oxygen for maintenance. Radiographs were performed with extended hind limbs and with abducted hind limbs following the FCI standards positioning (Figure 3).

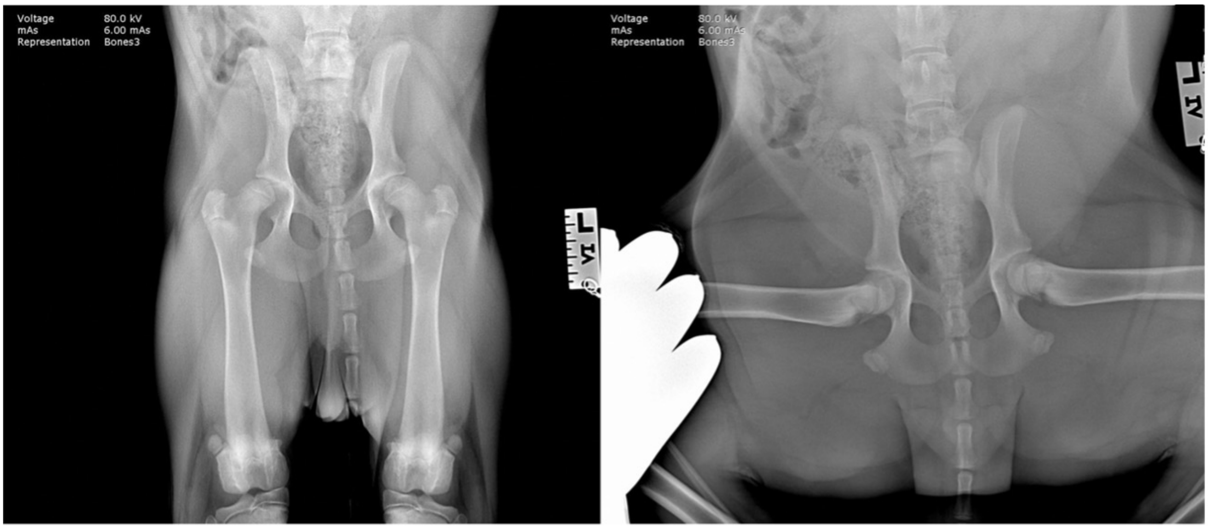

Figure 3 – Radiographic positioning in the FCI scoring (Images provided by Sirius Clinic)
Hip extended (left) and abducted (right) radiographic images

The radiographic examination demonstrated a distraction index greater than 0,7 (Figure 4) and slight osteoarthritic alterations on the cranial acetabular rim. Images of a two-dimensional CT scan show a DAR slope greater than 20º on both hips (Figure 5).

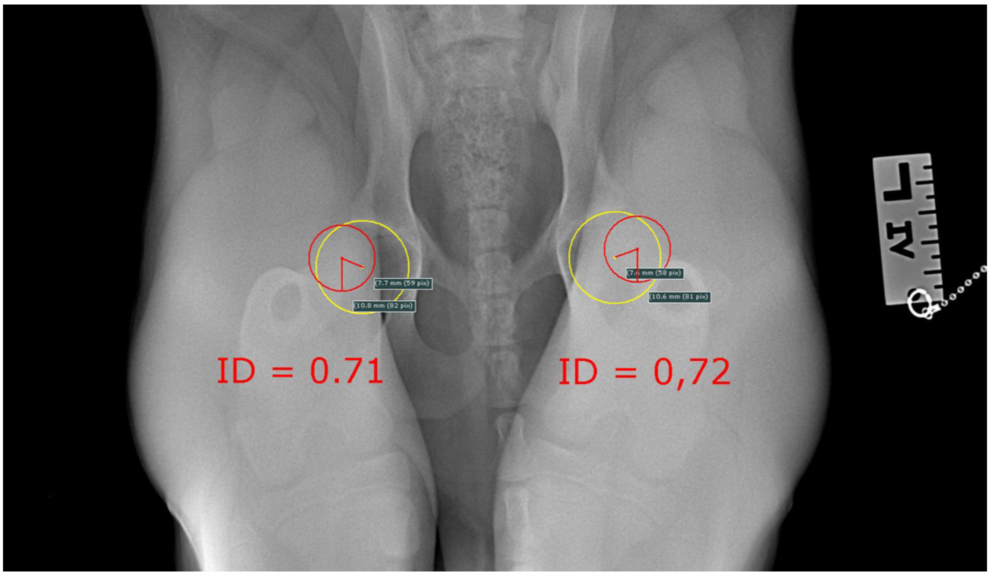

Figure 4 – Distraction index measurements on a distracted radiographic view (Images provided by Sirius Clinic)
(ID: Distraction Index)

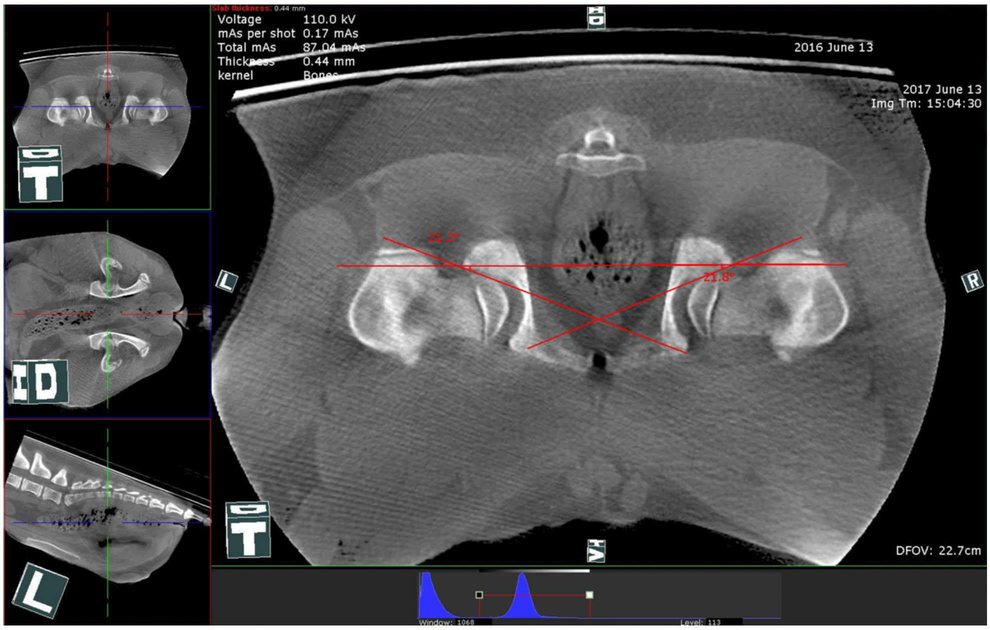

Figure 5 – Dorsal acetabular rim slope measurements on two-dimensional CT scan (Images provided by Sirius Clinic)

Based on the distraction index and DAR slope, it was established that the risk of developing moderate to severe coxofemoral dysplasia was high. A DARthroplasty on both coxofemoral joints was then considered and planned one month after the first consultation, starting with the left hind limb.

2.4. PRE-ANESTHETIC CLINICAL EVALUATION

The animal underwent a pre-anesthetic clinical evaluation and was classified as ASA I (American Society of Anesthesiologists), meaning a normal healthy patient with no obvious acute or chronic disease and a normal body mass index percentile for his age (ASA website).

2.5. PRE-SURGICAL PREPARATION

A Ringer Lactate saline infusion was given to the animal at a 5 ml/kg/h IV flow rate, along with amoxicillin and clavulanic acid (12,5 mg/kg SC) for the surgical antibiotic prophylaxis. Premedication was performed with medetomidine (11 µg/kg IV) and midazolam (0,2 mg/kg IV). Trichotomy was performed over the entire hip area, the anaesthesia was induced with propofol (1 mg/kg IV), and an endotracheal tube was placed. The animal was placed in lateral recumbency, and the anaesthesia was maintained with isoflurane (1,5% mixture in oxygen). A constant rate infusion of fentanyl (3 µg/kg/h IV), lidocaine (2 mg/kg/h IV), and ketamine (0,6 mg/kg/h IV), or FLK protocol, was also implemented during the intervention and for a few hours after. Asepsis was performed with a mixture of 70º modified alcohol and chlorhexidine digluconate 5% solution in a ratio of 9:1, respectively.

2.6. SURGICAL PROCEDURE: DARthroplasty

The coxofemoral joint was approached by a caudal intergluteal pathway, and the cutaneous incision was made parallel to the cranial limit of the biceps femoris muscle, from the sacrotuberous ligament over the major trochanter and extend it to the middle one third of the femur (Figure 6). The biceps femoris muscle were caudally retracted, and the gluteal muscles were cranially retracted.

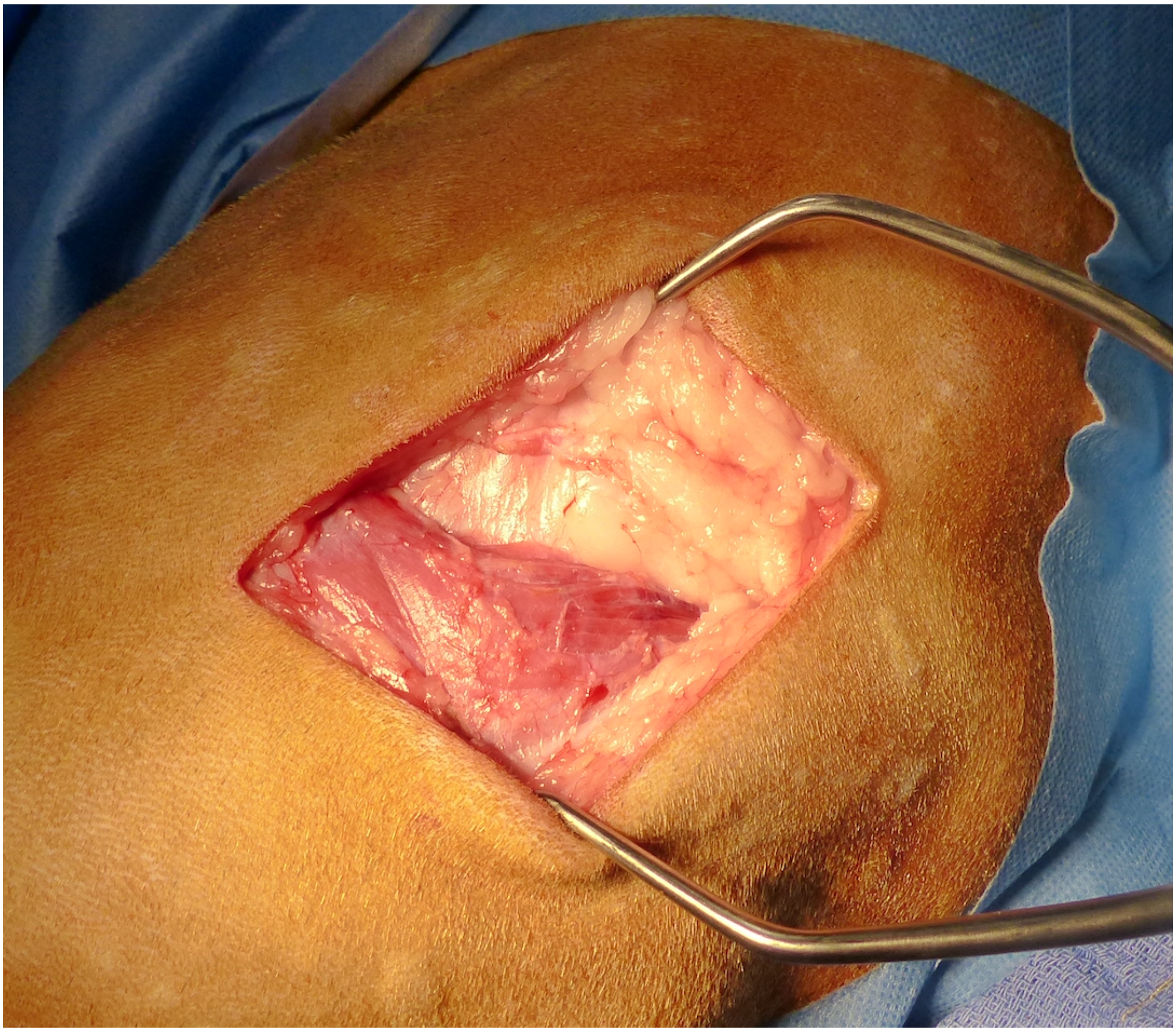

Figure 6 – First cutaneous incision (Images provided by Sirius Clinic)

The sacrotuberous ligament was identified and sectioned with care (Figure 7) to avoid the sciatic nerve entrapment in the ligament. A branch of the caudal gluteal artery on the gemellus muscles was coagulated with bipolar cautery to create an anatomical reference point from which dissection was deepened to reach the joint capsule. The dorsal capsule was then released from the muscular insertions of the gemellus muscles and the deep gluteal muscle.

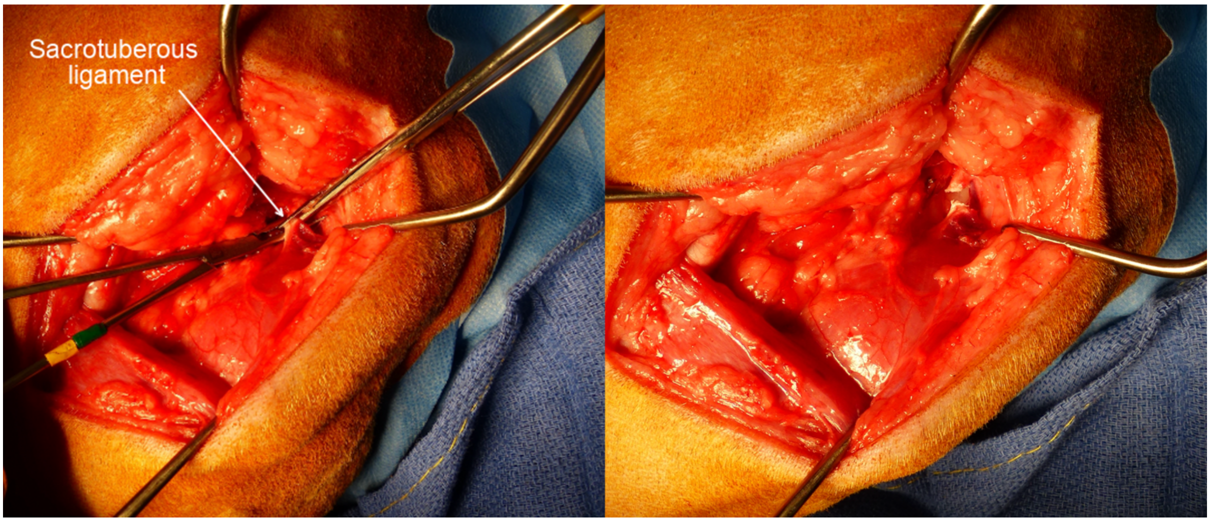

Figure 7 – Section of the sacrotuberous ligament (Images provided by Sirius Clinic)

A subperiosteal elevation of the muscles was performed on the dorsal acetabular region, allowing for the harvest of adequate size strips of corticocancellous bone graft. The fibrous insertion of the joint capsule should not be damaged during this step. A cavity was created between the articularis coxae muscle and the articular capsule by blunt dissection. This cavity will then receive the cranial end of the first bone strip and will be necessary to maintain the graft as close as possible to the femoral head. In the next step the gemellus muscles and the tendinous part of the obturator internus muscle were elevated from the joint capsule, creating a cavity that will receive the caudal ends of several bone grafts strips (Figure 8).

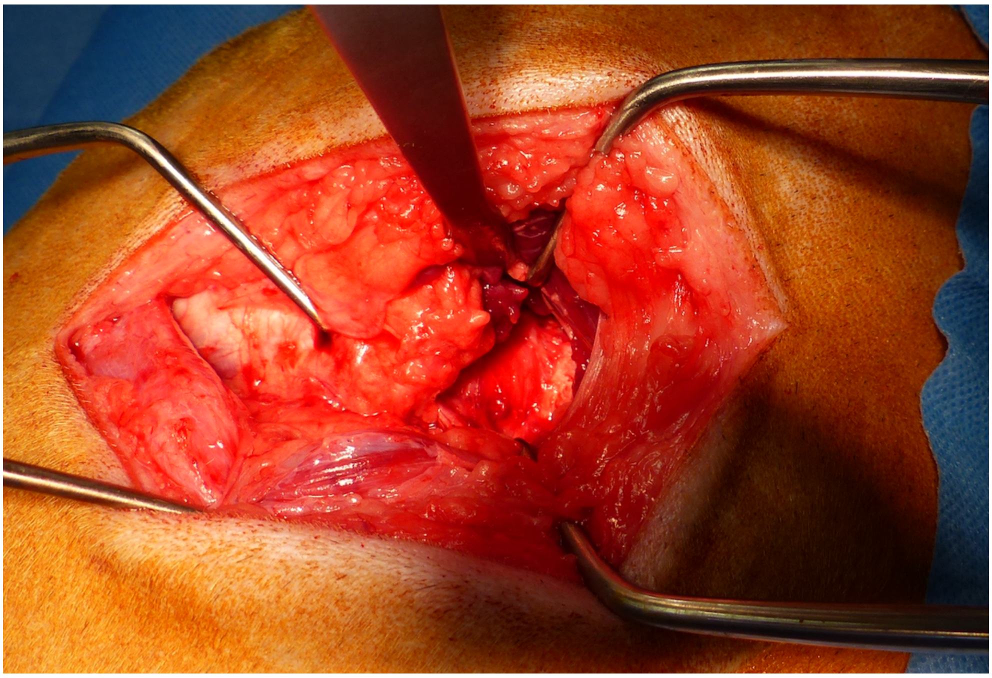

Figure 8 – Cavity created by blunt dissection of the gluteal muscles in the dorsocranial border of the acetabulum (Images provided by Sirius Clinic)

The hip should be placed in abduction for this step of the procedure as it will increase the space, allowing better visibility of the area. A Steinmann pin of 2,5 mm was inserted into the dorsal acetabulum at the most cranial area of the sulcus that will be created. The pin was then cranially bent in order to retract the gluteal and piriform muscles. A Homann or a Farabeuf retractor can also be used to increase visibility on the approached area. A strip of corticocancellous bone was collected from the dorsal acetabulum from its cranial end to its caudal end with a 4 mm Lexer bone gouge, creating a sulcus. The sulcus previously formed must reach the deep cancellous bone. After being removed, the cortical bone strip was placed on the dorsal edge of the capsule insertion.

Bone grafts were collected from the ipsilateral iliac wing. The skin incision was extended from the sacral tuberosity to the coxae tuberosity on the cranial part of the iliac wing and continues until the great trochanter (Figure 9).

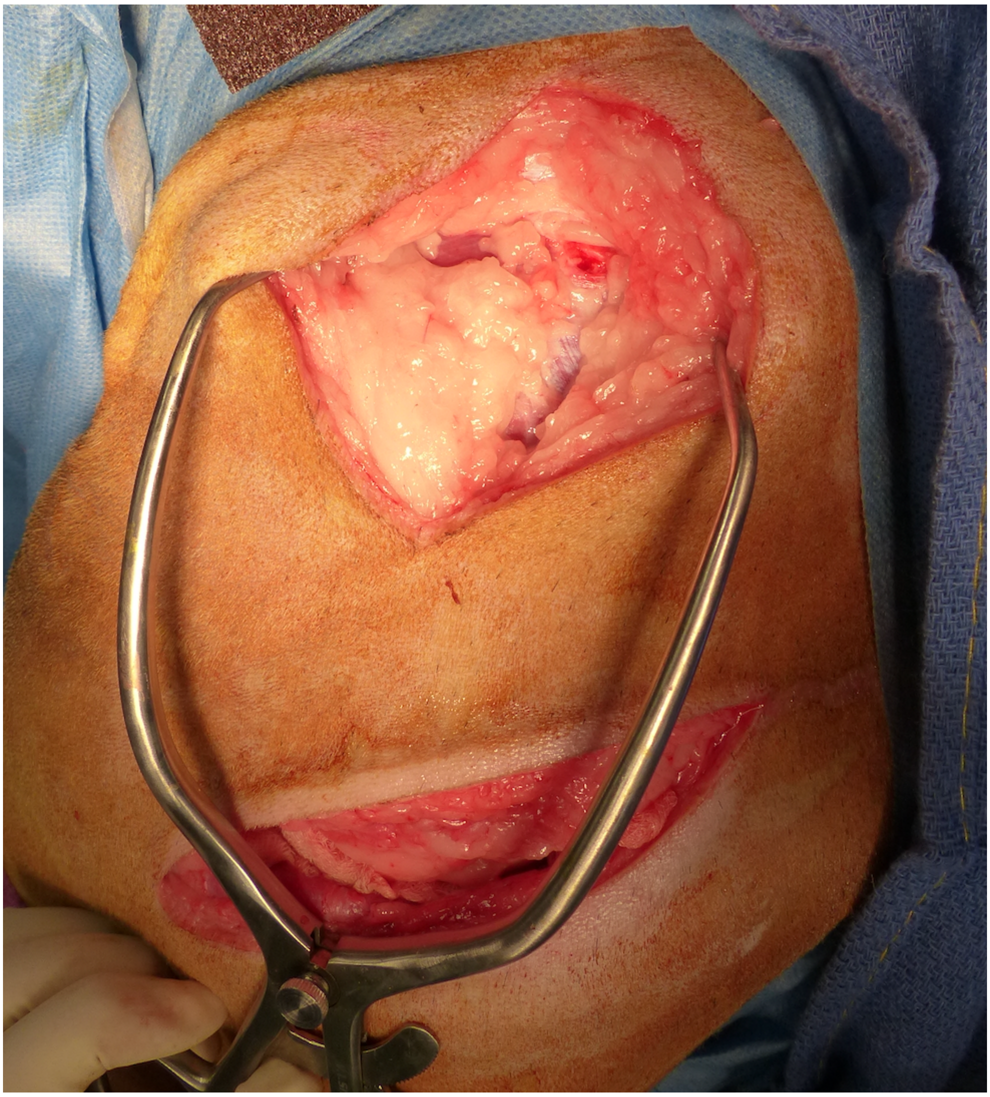

Figure 9 – Second cutaneous incision (Images provided by Sirius Clinic)

The incision size depends on the weight and conformation of the patient, about 10 cm for 35 kg, and must allow good access to the iliac wing to collect the grafts. The aponeurotic fascia covering the gluteus medius muscle was sectioned in the same direction as the cutaneous incision, and a periosteal elevator was positioned on the cranial margin of the iliac wing and caudally advanced to expose the bone for graft harvesting (Figure 10).

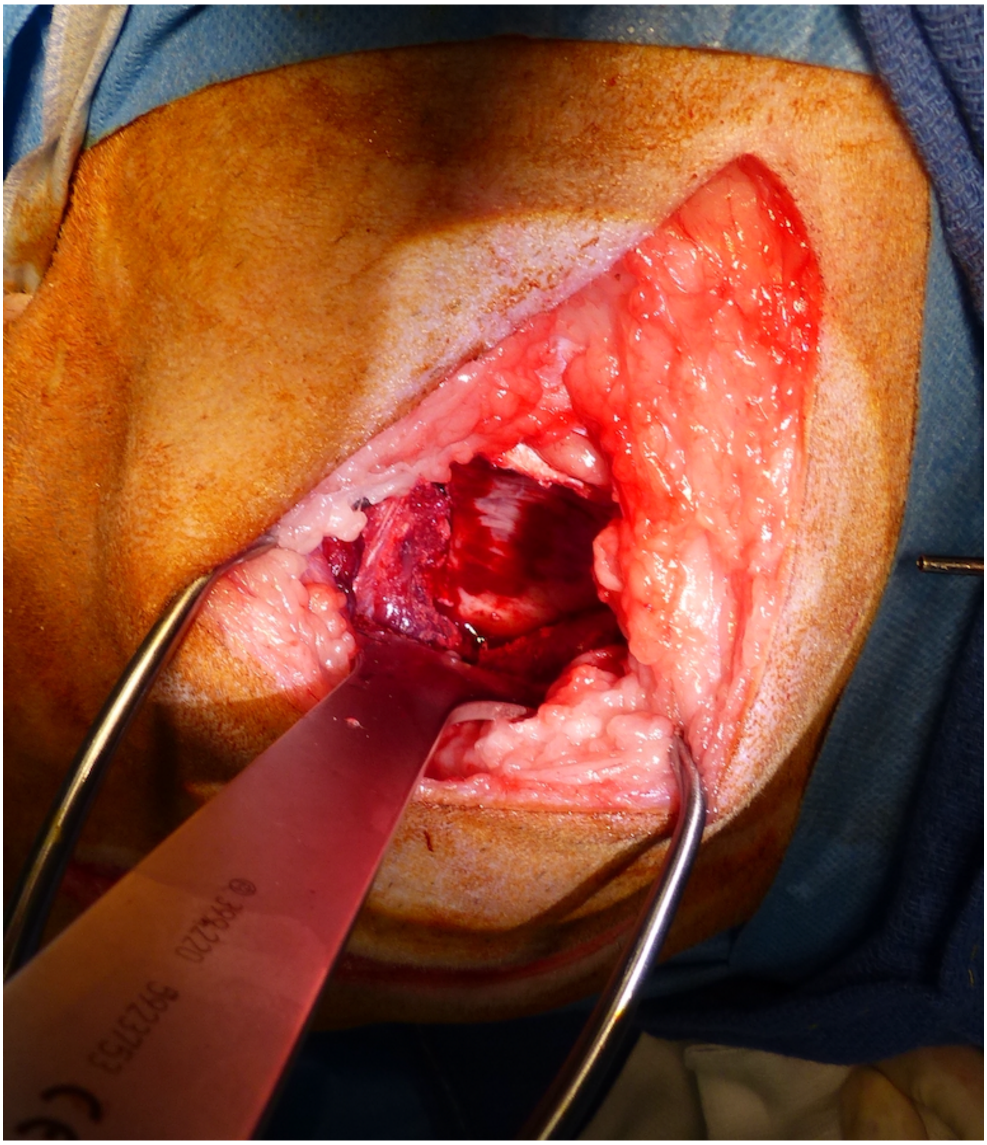

Figure 10 – Exposure of the graft sample area (Images provided by Sirius Clinic)

It is also recommended to release the muscle insertions of the iliac crest to have good exposure of the entire iliac wing. For this purpose, two incisions were made to allow a slight myotomy ventrally and dorsally to the ilium, bringing better visibility to the access. The incision thus performed has a T-shape, the large branch being in a cranial to caudal orientation.

The first strip of cortical bone was collected along the central axis of the iliac wing with a 10 mm wide Lexer bone gouge. The following two strips were collected parallel to the first, dorsally and ventrally.

Therefore, all the cortical bone of the sample area was removed. As the collected bone is too thick, additional cancellous bone strips must be removed, deepening the graft area (Figure 11).

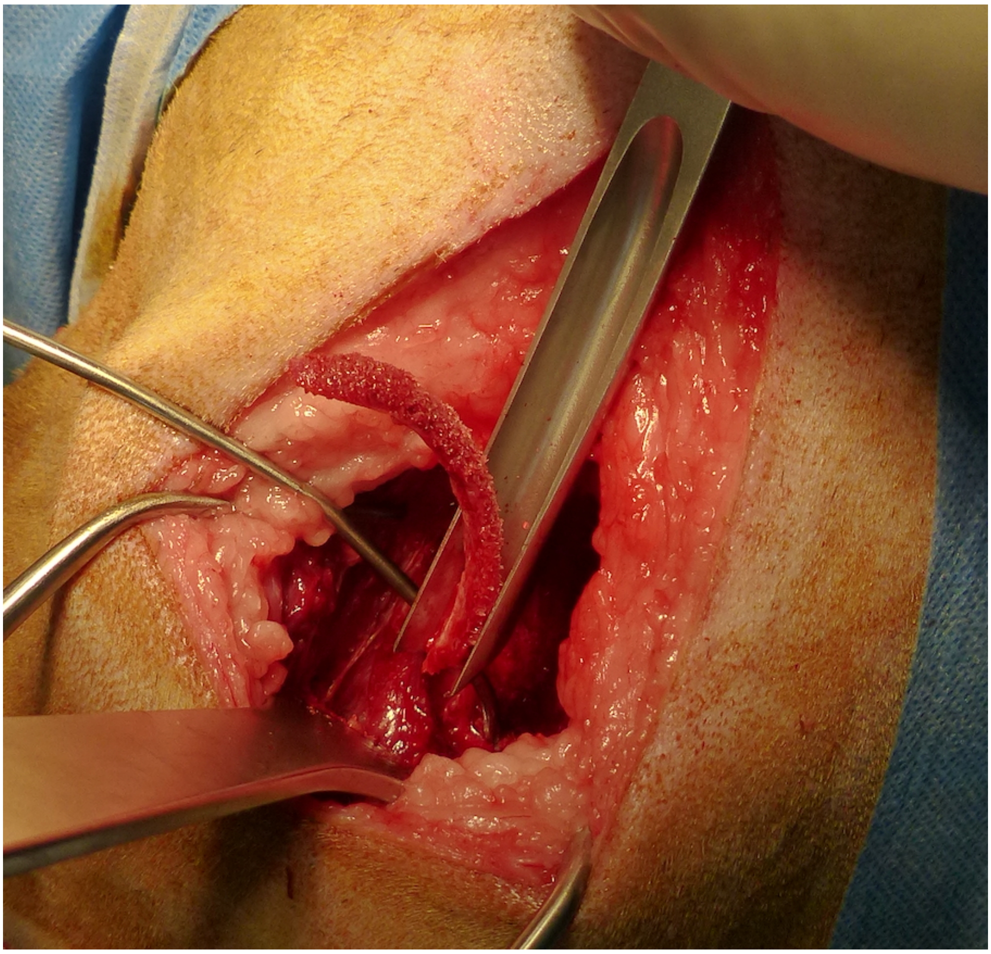

Figure 11 – Cancellous bone strip collected with a 10 mm Lexer bone gouge (Images provided by Sirius Clinic)

The first bone graft to be placed should have the best conformation among the grafts collected, preferentially from cancellous bone. This recommendation is not essential in dogs from four to six months old since almost all the bone sampled is cancellous, and the cortical bone is very malleable and porous. The graft was positioned between the femoral head and neck, parallel to the hip bone, as laterally as possible to the femoral head. The cranial end of the bone strip was placed in the previously created cavity, under the deep gluteal muscle, and its caudal end was inserted under the tendinous part of the obturator internus muscle.

The second graft was placed medially and paralleled to the first, and the following were placed in the same way until the sulcus previously shaped on the dorsal acetabulum was covered (Figure 12). Once the coxofemoral joint was well covered, the second layer of grafts was placed over the first one, taking care to position the hip in abduction to release muscular tensions that limit the access to the cranial cavity. The final volume of the graft should be as large and stable as possible. If necessary, it is possible to place a few pieces of grafts to fill in the empty spaces, compacting them on the main graft. The graft was stabilized by the two cranial and caudal cavities and by space restriction, but no suture was made for its stabilization.

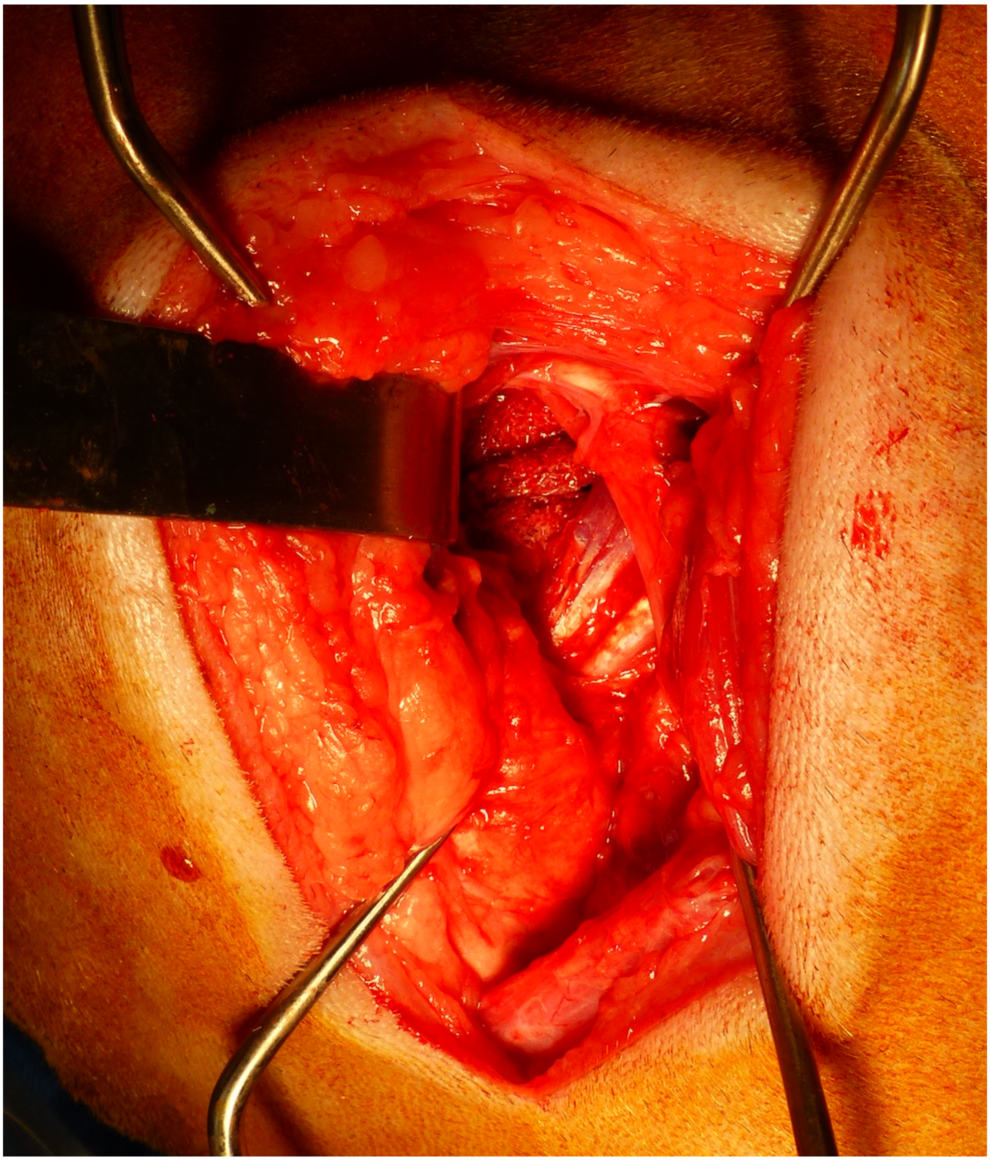

Figure 12 – Bone grafts covering the dorsal acetabulum (Images provided by Sirius Clinic)

The muscles, subcutaneous tissue, and skin were routinely sutured through a three-layer closure avoiding dead space formation. Muscles and subcutaneous tissue were sutured with resorbable synthetic monofilament suture thread (USP 3/0), and the skin was sutured with non-resorbable polyamide monofilament suture thread (USP 2/0). A bandage was then applied to protect the suture, using an antibacterial ointment with sulphapyridine underneath. No incidents were reported during surgery.

The DARthroplasty on the right hind limb was performed three months later. The patient had accumulated some fat through muscle wasting, so the surgery was more complicated and therefore had a longer duration. The premedication, induction, and handling of general anaesthesia were carried out in the same way and with the same drugs as the first intervention. The surgical technique and the post-operative care were similar to the ones achieved for the first procedure.

2.7. POST-OPERATIVE CARE

Post-operative care consisted of antibiotic therapy with amoxicillin and clavulanic acid for five days (10 mg/kg SC BID), analgesia with methadone (0,5 mg/kg IV TID for two days), and non-steroidal anti-inflammatory treatment with meloxicam (0,2 mg/kg IV SID after surgery, followed by 0,1 mg/kg PO SID for the next four days).

For this type of surgical intervention, the owners must restrict intense propulsion activities for three to four months, which means preventing the animal from jumping and running until complete integration and maturation of the graft. It was also recommended to minimize movements for the first 15 days after surgery and allow only short walks, exclusively while the animal is on a leash.

The bandage change was done three days after surgery. When the bandage was changed, a clinical evaluation revealed an improvement in the nervous function of the sciatic nerve from a moderate (straight after surgery) to a mild neurological deficit (three days after surgery). A superficial infection with a slight purulent discharge on two of the stitches was spotted 15 days after surgery at the supposed time of thread removal. A 10-days antibiotic therapy with cefalexin was then initiated (15 mg/kg PO BID), and the suture threads were not removed until the end of treatment. On the thirtieth post-operative day, the clinical examination showed a slight neurological deficit of the sciatic nerve still present on the left and moderate muscle loss caused by a lack of physical exercise of the left hind limb. Therefore, manual physiotherapy was considered with massages, passive mobilizations, stretching, and hydrotherapy sessions at a frequency of three to four weekly sessions.

2.8. IMAGING CHECK-UPS AND CLINICAL EVOLUTION

A radiographic check was scheduled 30 days and 90 days after the procedure. Another post-operative check-up by CT scan was scheduled six months after the procedure. On the first radiographic check-ups, no pain was noted at palpation of the limb, and radiographs of both coxofemoral joints were performed. Post-operative images obtained by CT scan showed a progression of bone mineralization from a few days to 180 days after the first surgery (Figures 13 and 14).

Another CT scan (Figure 15) and an arthroscopy of the coxofemoral joint (Figure 16) were planned 365 days after the first CT scan for cartilage evaluation. The anesthetic protocol was the same one used for the DARthroplasties.

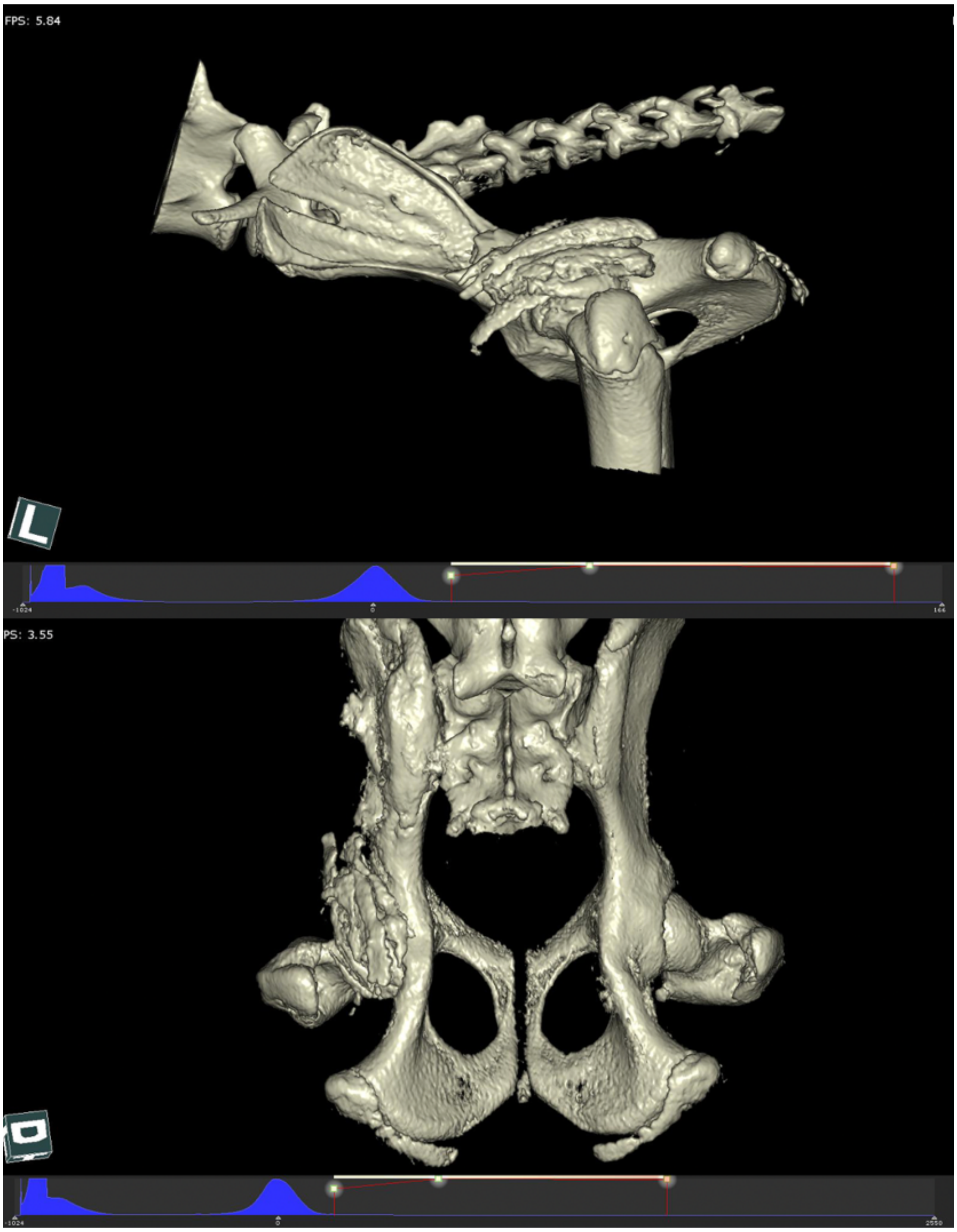

Figure 13 – Three-dimensional CT scan post-operative images of the pelvic region (Images provided by Sirius Clinic)

Lateral and dorsal view

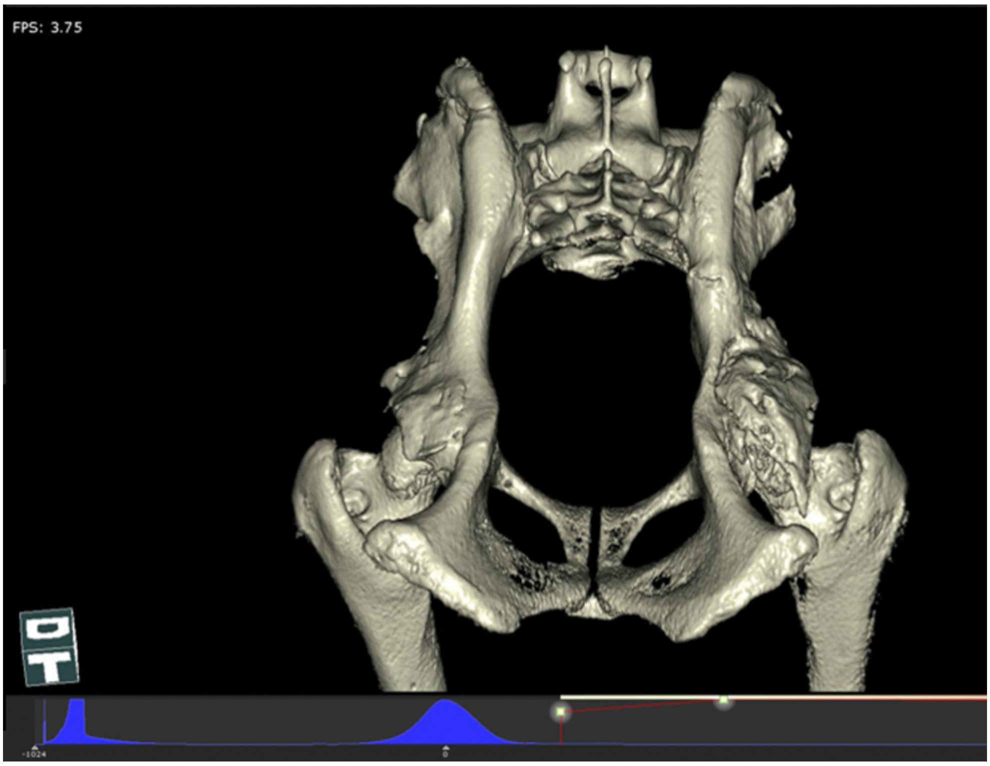

Figure 14 – Three-dimensional CT scan of the pelvic region 180 days after the first surgery (Images provided by Sirius Clinic)

Figure 15 - Three-dimensional CT scan of the pelvic region 360 days after the first surgery (Images provided by Sirius Clinic)

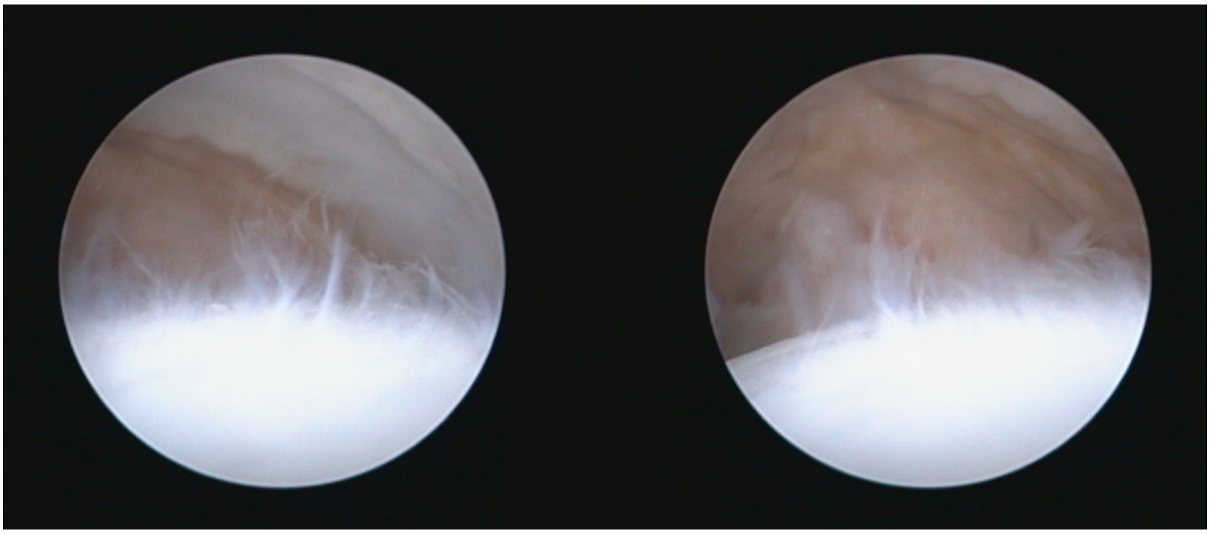

Figure 16 – Arthroscopic images of the left hip joint 360 days after the first surgery (Images provided by Sirius Clinic)

3. DISCUSSION

This case reports a dog received at the clinic for a hind limb lameness that was later diagnosed as an early stage of CHD, which was managed by surgical intervention with DARthroplasty. The case description was developed by assisting Dr. Frédéric Sanspoux in his activities and learning the current way to screen, treat and prevent CHD.

Conservative management for CHD is described as a nutritional, physical, and pharmacological therapy (Smith et al., 2018). Nutritional therapy consists of weight control to reduce overweight or obesity, which are risk factors for the progression of OA. Nutritional management includes prescription diets, controlled physical exercises, and eventual administration of pharmaceuticals or nutraceuticals (Innes, 2018). Physical therapy seems to be particularly efficient in chronic orthopedic conditions like OA, however, it is recommended only within a moderate and controlled activity with exercises such as swimming and walking on soft or padded surfaces (Lafuente & Koudelka, 2015). Pharmacological management of OA consists mainly of non-steroidal anti-inflammatory drugs (NSAIDs) and analgesics, which are symptom-modifying agents, and polysulfated glycosaminoglycan or pentosan polysulfate structure-modifying agents (Innes, 2018). A recent pharmacological therapy was also developed as an alternative to the use of NSAIDs for pain management, the anti-Nerve Growth Factor (anti-NGF) monoclonal antibodies (mAbs). This therapy could be used in different joint diseases that involves chronic pain and OA. Anti-NGF mAbs are biological agents that are isolated from humans, animals or microorganisms, but they need to be species-specific to prevent a possible immunoreaction. The mAbs bind to target molecules such as cells, receptors or cytokines, including NGF, and results in the target activity's blocking. In dogs and cats, the analgesic effect of anti-NGF mAbs is considered similar or greater than the NSAIDs analgesic effect. However, the effectivity of this therapy needs to be studied thoroughly, as the long-term administration of anti-NGF mAbs and the concomitant use of NSAIDs have not yet been studied in veterinary medicine (Enomoto et al., 2019). The success of conservative treatment for CHD depends considerably on the severity of the disease. Patients with severe functional affection caused by OA may require an arthroplasty surgery or even euthanasia, depending on clinical and economic factors (Innes, 2018).

Many surgical options were developed for the management of CHD by different approaches, including prophylactic, palliative, and salvage procedures. Prophylactic procedures are effective in young dogs with skeletal immaturity that does not yet present OA, palliative procedures are used to prevent pain caused by joint laxity or OA, and salvage procedures are aimed to eliminate the origin of pain and, for the total hip replacement (THR), to restore hip function in older dogs that already show clinical signs of OA (Vezzoni & Peck, 2018).

The prophylactic procedures are juvenile pubic symphysiodesis (JPS), double or triple pelvic osteotomy (DPO/TPO), and femoral neck lengthening, and the palliative procedures for CHD are denervation of the hip joint capsule, shelf arthroplasty, and intertrochanteric femoral osteotomy (Anderson, 2011). Other surgical techniques like pectineus myotomy, pectineus myectomy, and dorsal acetabular rim arthroplasty (DARthroplasty) are included in the palliative procedures because no study shows that they prevent the progression of OA, and they are rarely performed. The salvage procedures are the femoral head and neck excision and the total hip replacement (Anderson, 2011).

In this case, juvenile pubic symphysiodesis was not considered among the surgical options for the present case because the procedure would be ineffective at this age and would not show improvement. The ideal age for JPS to be effective is between 15 to 18 weeks old, or 18 to 22 weeks old in giant breed dogs (Anderson, 2011).

Triple pelvic osteotomy, or TPO, and double pelvic osteotomy, or DPO, aim to reduce joint laxity and the femoral head subluxation, increase the dorsal acetabular coverage of the femoral head, have a better congruity of the coxofemoral joint, relieve pain and increase hip stability (Guevara, 2017). TPO consists in three osteotomies on the ilium, ischium, and pubis that will isolate the acetabulum and rotate it by ventro-version (Vezzoni, 2010). DPO is a more recent surgical technique that was introduced by Haudiquet and Guillon in 2008, in the 14th ESVOT Congress Proceedings in Munich, Germany (Haudiquet et al., 2008). DPO aims to simplify TPO and consists in only two osteotomies on the ilium and the pubis, leaving the ischium intact. DPO also lead to an acetabular ventro-version, but by avoiding the ischiatic osteotomy, the objective is to reach a reduced mobility of the distal iliac segment in comparison with TPO (Vezzoni, 2010), improving hip stability to reduce the post-operative complication rate that had been reported with TPO.

The indication criteria for a DPO and TPO are similar, the patient must be between 5 to 14 months old, preferably younger than one year, and must still have some femoral coverage, no substantial OA, a non-damaged DAR (Guevara, 2017), and an angle of subluxation of less than 20º. The most common post-operative complications of pelvic osteotomies are the implant failure, screw loosening, and narrowing of the pelvic canal that are more frequently observed after a TPO than after a DPO, with a complication rate between 35 to 70%. DPO also results in a better ability to walk, stand and sit some hours after surgery, and a lower morbidity rate than TPO, allowing to perform the surgery on both sides simultaneously (Vezzoni, 2010). However, as DPO is a more modern surgical technique, the reduction of the post-operative complication rate may be related to advances in implant technology and the crescent use of locking plates. In order to verify these assumptions, further studies must be conducted on the comparative outcomes of DPO and TPO in the same patient type (Guevara, 2017).

The disadvantages of TPO compared to DPO are the excessive femoral head coverage that leads to an internal limb rotation during the walk, the higher morbidity and complication rate, and the incapacity to sit after the surgery because of ischial pain. The disadvantages of DPO compared to TPO is the difficulty of the surgical technique, and the need for the bone plate to have a greater angle than with TPO, to reach the same acetabular ventro-version (Vezzoni, 2010). For example, a study showed that a 25º DPO results in an acetabular angle similar to the one achieved with a 20º TPO (Punke, 2011).

For this case, DPO and TPO were considerable as an alternative for DARthroplasty, however it was established that the clinical outcomes of a pelvic osteotomy might be lower than expected due to the significant distraction index. To perform a pelvic osteotomy, the angle subluxation must be measured, and a pre-surgical arthroscopy must be done in order to see if there are acetabular fillings and cartilage damages on the hip joints. The surgeon choice for DARthroplasty was made with the previous considerations, and also for Dr.Sanspoux to train the surgical technique with Dr. Lourenço, as the patient was included in the indication criteria for DARthroplasty.

The procedure performed in this case is known as the modified Slocum technique for DARthroplasty. Initially, the Slocum procedure included sutures to stabilize the bone grafts (Slocum & Slocum, 1998), but in this case, no suture was applied, and the uptake of the bone graft was stimulated by the weight-bearing pressures that are physiologically applied to the joint. The DARthroplasty on the right hind limb was more complicated due to the patient's fat accumulation, however, the graft could be placed with a better acetabular cover.

Post-operative radiographs of the coxofemoral joints showed good mineralization of the graft and sufficient acetabular coverage. Three-dimensional CT-scan images also showed excellent progression with good mineralization of the graft, and sufficient acetabular coverage. The observation by arthroscopy showed grade II lesions according to the Outerbridge classification of chondral lesions. This classification system defines grade II as a partial-thickness cartilage defect with some fissures of 1,27 cm or less in diameter that do not affect the subchondral bone (Slattery & Kweon, 2018). The arthroscopy results were adequate, despite the finding of some cartilage fissures directly laterals to the ligamentum teres and a small frosting area on the cranial-proximal face, knowing that this region of the joint is under the most significant pressures. In addition, the animal's owners noted an improvement in the quality of movements and did not observe any further signs of lameness a year follow-up examination.

The original Slocum technique for DARthroplasty presumes that candidates for this procedure are dogs with CHD that still have intact joint cartilage present, especially dogs not included in TPO or THR indication criteria. Slocum & Slocum refer that the complications of this technique remain few, the major one being temporary sciatic dysfunction caused by an entrapment of the sciatic nerve between the sacrotuberous ligament and the bone graft (Slocum & Slocum, 1998). The sciatic entrapment can be avoided by severing the sacrotuberous ligament, but the effects of this ligament's transection are not deeply studied (Lozier, 2004).

A conference presentation done by Lozier in 2004 refers that the first category of indications for DARthroplasty includes patients with hip instability unrelated to bone conformation, and the second category includes patients for whom TPO or THR are not indicated that have more variable levels of incompletely reducible dorsolateral translation. Patients in the first category are candidates for minor DARthroplasty, with a single bone strip placement, and those in the second category must undergo standard or major DARthroplasty, with two or more bone strip placements. In this presentation, Lozier also suggests that one of the advantages of DARthroplasty is combining the procedure, simultaneously or afterward, with other interventions such as ipsilateral femoral neck lengthening, TPO, THR, or contralateral femoral head and neck excision (Lozier, 2004).

A case report about the outcomes of DARthroplasty combined with femoral neck lengthening compared with contralateral femoral head and neck excision on a 5-month-old dog concluded that the combined surgical procedures resulted in ameliorated hip laxity and greater acetabular coverage of the femoral head, along with a restriction of OA progression (Petazzoni & Dallago, 2019).

The advantages of DARthroplasty are the less invasive assessment compared to TPO and THR, the low morbidity, and the low complication rate. However, the disadvantages apply to the major DARthroplasty, because of the lack of adequate clinical outcomes compared to TPO or THR performed on the same patient type (Lozier, 2004).

4. CONCLUSION

This case report reveals the importance of adapting the treatments to different types of patients that can express varying degrees of dysplasia. Various therapeutical methods are used worldwide to manage CHD. In order to elect the most adapted method, it is essential to consider the age, breed, body condition, nutrition, parental hereditability, environment, and previous medical condition of the patient. In this particular type of disease, the severity and evolution of hip joint laxity and OA development, by interpreting radiographic, tomographic and arthroscopic images of the hip joint, with the intention of measuring the coxofemoral alignments on each specific case, are of extreme importance.

Another key point in the management of CHD is to execute multiple follow-ups of the patient for at least one year after medical or surgical treatment, to observe the clinical evolution and if osteoarthritic changes still appear on the hip joint. These follow-ups can be crucial to determine the outcomes and possible complications of the chosen therapy prematurely, to be able to pursue a better-adapted treatment whenever necessary.

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