

PROCEEDINGS

**33rd annual meeting of the
INTERNATIONAL ELBOW WORKING GROUP**



**September 24th 2018
WSAVA-FASAVA congress,
Marina Bay Sands Congress Venue,
Singapore.**

Welcome at the 33rd meeting of the International Elbow Working Group

The International Elbow Working Group (IEWG) is an affiliate of the World Small Animal Veterinary Association (WSAVA). The board of the IEWG is therefore very grateful to the organisers of the 43rd WSAVA congress and the 9th FASAVA congress, in particular to Dr Shane Ryan, chairman of the Congress Committee, and Dr Frédéric Gaschen, chairman of the Congress Scientific Program Committee to be invited and facilitated in organizing a seminar during the pre-congress meeting of the WSAVA-2018 congress. By this invitation, the WSAVA underpins the importance of the role of the IEWG to perform the task of exchanging important information to the world veterinary community regarding the causes, prevalence, screening, therapy and prevention of one of the most important non-traumatic diseases of the locomotion system in dogs. The IEWG fulfils this task by organizing annual meetings with the help of esteemed scientist in the field of genetics, radiology, orthopedic surgery, and related fields to present the newest science and overviews on Elbow Dysplasia. Earlier this month, the IEWG had a seminar at the World Veterinary Orthopedic Congress, a joined meeting of the European Society of Veterinary Orthopedics and Traumatology (ESVOT) and the American Veterinary Orthopedic Society (VOS), with participants of European countries and the America's.

The IEWG is happy to be able to share new information with participants of the Asian and other countries coming together in Singapore. On both occasions the importance of uniform screening of radiographs made of elbow joints to score the status of the elbows is emphasized. The grading for Elbow Dysplasia in an uniform way around the world plays an important role in national and international communication, and international veterinary literature, but also in international contacts of dog breeders and breeders organizations, as well as in import and export of breeding dogs around the world. Since veterinarians play a significant role in all these activities, an equal understanding about all aspects of Elbow Dysplasia and a uniform scoring system of the elbow status strengthens the position of the veterinarian consulted in this diversity of roles. Breeding measures to erase the genetic causes of Elbow Dysplasia will improve the health status in a variety of dog breeds at risk for Elbow Dysplasia and will improve the well-being of the individual dogs and their owner.

Also on behalf of the other board members of the IEWG, Dr Bernd Tellhelm treasurer and Dr. Thijs How secretary, I like to thank all speakers at the IEWG meeting for their efforts to prepare their presentation and their proceedings text, and I like to acknowledge the committee members of the WSAVA-2018 congress for their hospitality towards IEWG and its participants and wish all congress participants a fruitful stay in Singapore.

Those who could not attend the meeting in Singapore are kindly invited to visit the webpage of the IEWG (www.vet-iewg.org), where the proceedings text of this and previous congresses are available for all veterinarians interested in Elbow Dysplasia in dogs.

Herman A.W. Hazewinkel,
President I.E.W.G.



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Scientific program

09.00 – 09.10	Welcome, Prof. Dr. H.A.W. Hazewinkel (NL), president IEWG.
09.10 – 09.30	Clinical signs of Elbow Dysplasia, Dr. K.L. How (NL).
09.30 – 10.00	Etiology of fragmented coronoid process (FCP), Dr. S.F. Lau (MY).
10.00 – 10.30	Etiology of ununited anconeal process (UAP), osteochondritis dissecans (OCD) and elbow incongruity (EI), Dr. K.L. How (NL).
10.30 – 11.00	Break.
11.00 – 12.00	Surgical treatment of FCP, UAP, OCD and EI, Prof. Dr. R.H. Palmer (USA).
12.00 – 12.45	Radiological investigation of dogs suspect of Elbow Dysplasia, Prof. Dr. L. Gaschen (USA).
12.45 – 13.15	Screening for Elbow Dysplasia, grading according to IEWG, Prof. Dr. H.A.W. Hazewinkel (NL).
13.00 – 13.30	Closing discussion.



List of speakers

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Clinical signs of Elbow Dysplasia.

Dr. K.L. How, DVM, NACAM Specialist in SA Surgery,

Front leg lameness in young large and giant breed dogs is most often caused by Elbow Dysplasia [ED]. Elbow Dysplasia is a multifactorial disease process with a genetic predisposition and secondary environmental influences. These influences include overnutrition, rapid growth, excessive exercise, and hormonal influences. There are 4 diseases that are grouped under the umbrella name of Elbow Dysplasia; ununited anconeal process [UAP], osteochondritis dissecans [OCD], medial coronoid process disease [MCPD] and elbow incongruity [INC]. Elbow Dysplasia can affect one or both front legs and several forms of ED can be present in one leg.

History

In the history of a patient with front leg lameness general health, breed, gender, age of onset, description and moment of lameness, chronological progression and efficacy of treatment is important. The typical ED patient is a healthy young dog with one sided or bilateral, starting front leg lameness, worsening over time. Many large and giant breed dogs are affected with ED. UAP is more frequently diagnosed in German Sheppard Dogs. UAP and INC are also found in chondrodystrophic breeds. In Labradors, male dogs are affected twice as frequent as females, whereas in other breeds (e.g. Bernese Mountain dogs) there is no gender predilection for ED. Lameness becomes apparent from 5 – 7 months of age and starts oftentimes with inactivity stiffness in the morning or after resting.

First impression and locomotion

During the history taking a first impression of the stance and locomotion can be obtained by watching the dog in the consultation room. Gait analysis can be done next by walking and trotting the dog outside on the leash. Lameness can sometimes become more apparent during tight circles or walking stairs. Home movies made by the owners, can also be very helpful in cases where the dog doesn't show the lameness in a unfamiliar environment.

During walking the dog will favour the best leg by putting more weight on it (so called "head bobbing"). The leg with the effected elbow will be circumducted laterally during the swing phase of the gait. The animal may sit or stand with the paw externally rotated [i.e., slight supination of the under arm] [fig.1]. In about one to two third of the cases the problem is both sided and therefor limping may not always be very obvious. In both sided cases the dog may shift weight from one side to another during standing. Walking can be with a short and stiff stride, with more weight put on the hindlegs. The use of a lameness scale for standing, walking and trotting can be a useful tool to record and evaluate the locomotion over time.

Physical examination

Physical examination must be done with the dog standing and in lateral recumbency.

In standing position the dog should be positioned as symmetrically as possible and both legs are examined simultaneously for muscle atrophy and soft tissue

swelling. Elbow joint swelling can be palpated in the standing dog between the lateral humeral epicondyle and the olecranon [fig. 2]. Also periarticular joint swelling can be palpable in more severe cases. Both legs are lifted separately, to evaluate the amount of loading of each leg.



Figure 1: Externally rotated frontleg

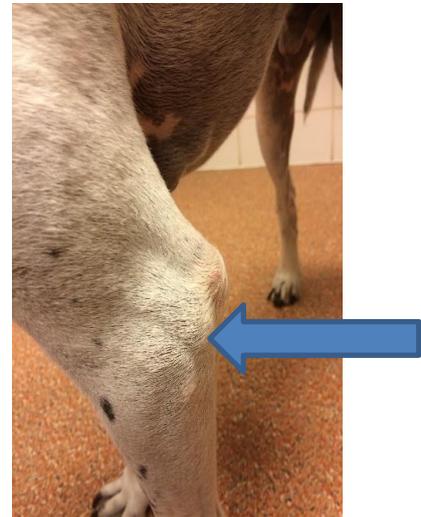


Figure 2: Elbow joint swelling [arrow]

The examination in lateral recumbency can best be started with the normal leg first to let the animal get used to the examination and to get used to individual responses. The examination is from toe to shoulder and stability, crepitus, painful regions and the range of motion can be evaluated. Normally no pain is elicited during the examination. Abnormal areas or manoeuvres that may produce pain should be examined last and obvious responses should be gently repeated. The elbow joint can have a smaller range of motion and pain can be elicited by hyperextension of the elbow with lateral rotation [supination][fig.3]. Crepitation during passive motion can be felt in advanced cases of arthrosis.



Figure 3: hyperextension with lateral rotation in lateral recumbency

To avoid misinterpretations, attention must be paid not to flex or bend the shoulder while manipulating the elbow. Possible problems in the shoulder joint, [OCD of the proximal humerus] by hyperflexion and hyperextension of the shoulder joint and tendinitis of the biceps muscle [by flexion of the shoulder joint and concomitantly extension of the elbow joint], but also enostosis of the long bones [by deep palpation of the long bones of all four legs]/ and trauma of the bones and ligaments of the elbow must be ruled out.

Diagnostic Imaging

The next step is to finalise the diagnosis with further diagnostic imaging. With a definitive diagnosis an optimal treatment plan can be made.

Radiography, CT, MRI, arthrocentesis, ultrasound, bone scintigraphy and arthroscopy all have their values and will be discussed during the IEWG 2018 meeting.

Suggested reading

- S.F. Lau, L.F.H. Theyse, G. Voorhout, H.A.W. Hazewinkel: Radiographic, Computed Tomographic and Arthroscopic Findings in Labrador Retrievers With Medial Coronoid Disease. *Vet. Surgery* 44 [2015]: 511-520.
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- J.P. Punke, D.A. Hulse, S.C. Kerwin, L.E. Peycke: Arthroscopic Documentation of Elbow Cartilage Pathology in Dogs with Clinical Lameness without Changes on Standard Radiographic Projections. *Vet. Surgery* 38 [2009]: 209-212.
- H.A.W. Hazewinkel: Elbow Dysplasia; definitions and clinical diagnoses. *Proceedings 23rd Annual Meeting IEWG, Dublin, Ireland* [2008]: 5-11.
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Etiologies of Medial Coronoid Disease

Dr. S.F. Lau, DVM, PhD; Dr. H.A.W. Hazewinkel, Prof., DVM, PhD, Dipl. ECVS, Dipl. ECVCN; Dr. G. Voorhout, Prof., DVM, PhD, Dipl. ECVDI

Introduction

As one of the most frequently diagnosed heritable orthopaedic disorders of dogs, medial coronoid disease (MCD) usually affects young, large breed dogs. This disease of the medial coronoid process (MCP) was first called “*united medial coronoid process*” of the canine elbow joint and was described as the presence of an ossified bone loosely attached to the MCP of the ulna (Tirgari, 1974). In later years, it became known as “*fragmented medial coronoid process (FMCP)*”. The term “medial coronoid disease (MCD)” was introduced in 2008 as being a more representative term for FMCP, as it encompasses lesions of both articular cartilage and subchondral bone (Moore *et al.*, 2008; Fitzpatrick *et al.*, 2009). Despite of the extensive research, the etiology of MCD remains uncertain. There are different theories regarding the etiology of MCD.

Etiologies of Medial Coronoid Disease

Heritable disease

The disease is suggested to have a multifactorial and polygenic origin. The disturbance of one or more collagen genes in an indirect manner (disturbance in expression or alteration in post-translational modification) may cause MCD (Guthrie & Pidduck, 1990; Lavrijsen *et al.*, 2012). The causative genes have not yet been identified and breed-specific genetic control is postulated (Oberbauer *et al.*, 2017). MCD was also believed to be caused by osteochondrosis (OC), which is defined as a focal disturbance of endochondral ossification of articular cartilage in growing animals (Olsson, 1981). The occurrence of osteochondrotic lesions has been associated with chondronecrosis, caused by a failure of blood supply to growing cartilage. In one of the studies following the development of incipient MCD by using radiography and computed tomography, the histological results showed that MCD in Labrador retrievers is most likely the product of delayed endochondral ossification at the lateral aspect of the MCP at the level of the base of the MCP, with focus on the delay in calcification of the calcifying zone without concurrent abnormalities in the superficial layers of the joint cartilage. The persistence of retained cartilage provides a weak point at the cartilage-bone interface, where biomechanical forces may initiate cleft formation (Lau *et al.*, 2013).

Abnormalities of the underlying subchondral bone

In the 1990s and 2000s, results from histological studies were more supportive of MCD to be caused by abnormalities of the underlying subchondral bone. The size of fatigue microcracks increased by an increase of disease severity and damage being more severe at the fragmented site than at the rest of the bone (Danielson *et al.*, 2006). The loss of osteocytes with more pronounced osteoporosis of the fragmented MCP has also been reported. Later studies with dual-energy x-ray absorptiometry (DEXA) showed the mean bone mineral density of the MCP to be lower in MCD-positive animals than in controls. In both groups, bone mineral density was 50% lower at the axial border of the MCP than at the abaxial border. This suggests that the abaxial border might be more resistant to compressive loading than the axial border, and that this difference might predisposes the axial border of the MCP to develop microcracks. An increase in bone density at the

MCP and ulnar trochlear notch, was also suggested to contribute to the development of MCD (Smith *et al.*, 2009). Subtrochlear notch sclerosis (STS), which is characterized by increased radiopacity adjacent to the ulnar trochlear notch and caudal to the coronoid process, is an important indicator in diagnosing MCD radiographically (Mostafa *et al.*, 2018). It has been debated whether STS is the cause of MCD or the result of secondary degenerative changes. It was postulated as a cause of MCD with the explanation that increased stiffness of subchondral bone would cause the overlying articular cartilage layer to become more vulnerable to injury. However, in early development of MCD there is no STS present and thus it is now considered to be secondary, either to inflammation or due to mechanical overloading (Lau *et al.*, 2013).

Abnormal mechanical loading

Another postulated important cause of MCD was abnormal mechanical loading, which might be due to changes in joint alignment and spaces that result in radioulnar incongruence (RUI) because of a disparity in the length of the radius and ulna, underdevelopment of the ulnar trochlear notch, or physiological incongruity during loading. But the application of this postulation to certain breed might not appear to be correct (Rohwedder *et al.*, 2017). Other possible causes or factors contributing to MCD development include changes in the magnitude and topographic distribution of loading, pressure, forces within the joint, or tensile forces originating from the annular ligament, and shear stress between the contact area of the proximal radial head and the axial border of the MCP during pronation and supination. It has been suggested that biceps brachii/brachialis muscle complex in relation to the bony anatomy might lead to rotational instability, and give rise to shear planes between the radial head and the radial incisure of the MCP. This may result in micro-damage or even fragmentation of the MCP. The role of the shape of the MCP, trochlear notch, and the articular contact areas in the development of MCD also had been investigated. Compared between different breeds, there is high variability between growth in the length and width of the MCP. Large breed dogs are believed to have a less pronounced growth in length of the MCP in comparison to the width of the MCP during growth of the elbow joint, resulting in a more obtuse shape of the MCP in comparison with small breed dogs. Hence, loading and forces acting on the MCP might be larger in large breed dogs than expected. A difference in the rate of ossification between small and large breed dogs is suggested to predispose large breed dogs to MCD: ossification of the MCP is completed significantly earlier in small breed dogs than in large breed dogs, and slow maturation of the MCP is believed to be a cause of MCD in larger dogs.

In addition, other environmental factors such as nutrition, mineral imbalance, exercise, and microtrauma cannot be ruled out as playing a role in MCD development and this has yet to be investigated.

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Ethiology of Ununited Anconeal Process [UAP], Osteochondritis Dissecans [OCD] and Elbow Incongruity [EI]

Dr. K.L. How, DVM, NACAM Specialist in SA Surgery

Elbow Dysplasia or Developmental Elbow Disease is a multifactorial, developmental condition of the elbow joint, composed of 4 well known forms; Medial Coronoid Process Disease [MCPS], Ununited Anconeal Process [UAP], Osteochondritis Dissecans [OCD], and Elbow Incongruity [EI]. The MCPD is the most common manifestation of canine elbow dysplasia and will be discussed by Dr. Lau at this meeting. This presentation will focus on UAP, OCD, and EI.

Ununited Anconeal Process

The anconeus process forms the proximal end of the trochlear notch and articulates with the humerus by engaging the supratrochlear foramen at the olecranon fossa. This process provides stability to the elbow joint by limiting mediolateral movement when engaging the humerus.

The anconeal process has a separate ossification centre in most large breed dogs. Depending on the breed, the ossification centre of the anconeal process mineralizes between 10 and 16 weeks of age, with complete fusion to the ulna normally by 16 to 20 weeks of age. The UAP is found primarily in large-breed dogs, especially German shepherd dog, basset hounds, and the Saint Bernard. In some giant breed dogs like the St. Bernard and also in the basset hound, fusion of the anconeal process to the ulna can take longer.

Failure of the fusion of the anconeal process to the proximal ulnar metaphysis with 5 months of age in most large breed dogs or 8 months of age in St. Bernards and basset hounds leads to condition known as the Ununited Anconeal Process [UAP]. This condition can be bilateral and will lead to instability, displacement of the anconeal process and secondary osteoarthritis of the elbow joint.

Risk factors for the development of UAP are adult body weight, familial genetics, hormonal factors, osteochondrosis and growth disturbance of the proximal ulna [elliptical semilunar notch gives poor articulation with the humerus resulting in increased pressure against the anconeal process]. This is seen more often in the chondrodystrophic breeds.

Osteochondritis dissecans of the medial humeral condyle

Osteochondrosis is a disturbance in the process of enchondral ossification in a focal area of a developing articular surface centered at the osteochondral junction. The cartilage in the affected site fails to undergo physiologic calcification and replacement by bone, leaving a thickened focal area of degenerative cartilage.

This area of necrotic cartilage and fibrous tissue is vulnerable to shearing forces encountered during normal weight bearing and may become dislodged from the underlying bone, forming a flap. This lesion is referred to as osteochondritis dissecans [OCD]. When the flap forms, cartilage degradation products reach the synovial fluid, causing synovitis, joint pain and lameness. The resulting flap of cartilage may remain within the defect or may become dislodged.

In the elbow joint, OCD typically affect the medial condyle of the humerus.

Retrievers, Bernese mountain dogs and Rottweilers are the breeds most frequent affected. This can be bilateral and clinical signs start from 5-8 months.

The exact cause of OCD has not been determined, but a multifactorial complex of factors, including genetics, rapid growth, overnutrition and excess dietary calcium, trauma, ischemia, and hormonal influences, has been implicated.

Abrasion of joint cartilage resulting from humeral-ulnar conflict can give OCD-like lesions of the medial condyle of the humerus, and are called "kissing lesions".

Kissing lesions are oftentimes narrower and longer than the OCD bed.

Elbow Incongruity

There are three joints in the elbow; the humeroradial, humeroulnar and radioulnar. Elbow joint incongruity [EI] is thought mainly to be secondary to a length mismatch between the radius and ulna, with a short radius leading to MCPD by excessive cyclic loading. A short ulna however can displace the humeral head proximally relative to the ulna and places excessive loads on the anconeal process. This can interfere with bony union of the anconeal process in dogs with separate ossification centre, what could lead to an UAP. This is seen in chondrodystrophic breeds.

Radioulnar incongruity is the most common form of EI and can be caused by physeal trauma or congenital factors. Also humeroulnar incongruity, leading to displacement of the humeral head cranially from the ulnar notch, and radioulnar incisure incongruity and biceps/brachialis mismatch can contribute to EI. Plain radiography is not very sensitive in detecting elbow incongruity. The increasing use of arthroscopy and computerised tomography imaging has led to more accurate diagnosis of elbow incongruity.

Suggested reading

- S.F. Lau, L.F.H. Theyse, G. Voorhout, H.A.W. Hazewinkel: Radiographic, Computed Tomographic and Arthroscopic Findings in Labrador Retrievers With Medial Coronoid Disease. *Vet. Surgery* 44 [2015]: 511-520.
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Surgical Treatment of Canine Elbow Dysplasia (MCPD, UAP, OCD, EI)

Dr. R.H. Palmer, Prof., DVM, MS, Diplomate ACVS

Introduction

The most commonly treated manifestations of canine elbow dysplasia (CED) include medial coronoid process disease (MCPD), osteochondritis dissecans (OCD), un-united anconeal process (UAP) and elbow incongruity (EI). Even within a single manifestation of CED, there is a wide spectrum of etiopathogenesis and clinical presentations. Therefore, a similarly wide array of potential treatment options is available. Treatment may consist of non-surgical and/or surgical therapies. Non-surgical therapy includes weight management, optimized nutritional support, modified patient activity, nutraceuticals, pharmacotherapies, biologic therapies and physical rehabilitation. Surgical therapies are widely varied and treatment should be individualized to each patient based upon the best current understanding of the etiopathogenesis of the disease. The biggest challenge facing the veterinarian may well be selection of the appropriate treatment more so than the actual technical performance of it.

Medial Coronoid Process Disease (MCPD) and Elbow Incongruity (EI)

Previously called “fragmented medial coronoid process” (FMCP), the term “medial coronoid process disease” encompasses various MCP pathologies including overt fragmentation, fissuring, chondromalacia, and cartilage erosion. MCPD is a complex disease process with a wide array of presentations and responses to various therapies. Some inherent disease variation is expected based upon different severities and stages and patient ages at the time of presentation. Further, MCPD may not even be a single disease; rather it may merely be an anatomic localization of a various diseases each with a different underlying etiopathogenesis.

Surgical options include: (1) fragment removal with varying degrees of regional debridement (2) subtotal coronoid ostectomy (SCO), (3) complete tenotomy of the ulnar insertion of the biceps/brachialis complex (BBC), and (4) ulnar osteotomy/ostectomy. Procedures such as sliding humeral osteotomy (SHO), canine uni-compartmental elbow (CUE) and proximal abducting ulnar osteotomy (PAUL) are often, though not exclusively, reserved for patients with advanced or end-stage medial compartment disease (MCD) – these will be discussed in these notes.

Arthroscopy vs. arthrotomy vs. medical therapy. Meta-analysis of 400 studies concluded that the outcome of arthroscopic treatment was superior to medial arthrotomy and medical treatment.¹ Conversely, others reported that dogs with MCPD worsened at 1- and 2-months following arthroscopic treatment and that there was no difference between this cohort (11 dogs) and a non-surgically treated cohort (9 dogs) at 6- and 12-months postoperatively.² The study was criticized for not characterizing the true severity of disease in the non-surgical treatment group (radiographs only) as well as the likelihood of a Type II statistical error. Mini-

arthrotomy (MCL-sparing) for subtotal coronoidectomy was reported to have good results.³

Subtotal Coronoid Osteotomy (SCO). The rationale for SCO is that standardized removal of the majority of the MCP would include all fragments as well as grossly unapparent diseased cartilage and bone that may be missed by fragment removal and MCP debridement alone.^{3,4} In a prospective study of 263 dogs with MCPD treated via SCO, subjective lameness improvement at 12 weeks in 72% (veterinary exam) and 91% (owner questionnaire) and absence of lameness in 51% of limbs were reported. Owner questionnaire showed that 84% of dogs in that study were not requiring NSAIDs.³ A recent report on 14 dogs with unilateral MCPD treated via arthroscopic SCO found improved kinetics (not full restoration of function), no change in kinematic variables and progression of radiographic OA and progressive loss of passive range of motion, especially maximal flexion.⁵ One concern with SCO is that it could result in local joint load redistribution. To that end, acute cartilage eburnation of the humeral trochlea was reported 1-3 month following SCO in 6 elbows treated for FMCP and varying RUI. They suggested that SCO may promote humero-ulnar impingement along the osteotomy line in some patients for ill-defined reasons and raised the question of the importance of amount of resected MCP (too much vs too little), concomitant joint pathologies such as RUI or instability.⁶

Ulnar Osteotomy/Osteotomy (UO): Many variations of ulnar osteotomy/osteotomy are described with the intended purpose of unloading the MCP. Variations include level of the osteotomy relative to the interosseous ligament, the role of interosseous ligament and/or interosseous membrane release – with patient age as a potentially important variable, osteotomy vs. osteotomy and osteotomy configuration. **Ulnar Osteotomy level and soft tissue release** - The interosseous ligament may be more compliant in dogs < 6 months of age and, therefore, the position of the UO relative to it may, theoretically, be less important in these patients; though to my knowledge this has not been decisively investigated to date. In a skeletally-mature canine cadaveric mechanical model of linear traction applied to the proximal ulnar segment, greater proximal ulnar segment displacement was seen with proximal ulnar osteotomy (PUO) compared to distal ulnar osteotomy (DUO). However, when DUO was combined with interosseous ligament release (ILR), there was no difference compared to PUO alone.⁷ Another study investigated the effect of oblique PUO with IM fixation to DUO, DUO + ILR (interosseous ligament release) and DUO + CR (complete release of the interosseous ligament, membrane and entire ulnar attachment of the abductor pollicis longus) upon joint surface loading.⁸ In this study, they induced a long ulna (relative to radius length) incongruence; this is referred to as “positive axial radius-ulnar incongruence” (+ RUI). They showed that +RUI caused a shift of joint contact pressures to the medial joint compartment that was reduced only by PUO or DUO + CR. A clinical study of 13 large breed dogs (6m-10yrs of age) with MCD and elbow incongruity sought to evaluate the effect of osteotomy level. In that study, the UO was randomly assigned to proximal (7 bi-oblique dynamic proximal UO's) or midshaft (4 transverse, 2 short oblique dynamic osteotomies) locations and were radiographed postop and until healing. They showed PUO allows increased movement of the proximal segment (different results may be achieved if distal osteotomy is performed in conjunction with interosseous ligament release or in dogs < 5-6 months of age.⁹ **3-D movement of the Proximal**

Ulnar Segment - Originally, the simplistic view was that ulnar osteotomy, performed at the proper level and with appropriate soft tissue release, would allow distal translation of the proximal ulnar segment (via humero-ulnar load transmission) to relieve over-loading of the MCP. Biomechanical testing showed varus deviation of the proximal ulnar segment during limb loading when transverse PUO was performed in attempt to improve radio-ulnar contact patterns in elbows with induced radio-ulnar step incongruity.¹⁰ The multi-planar imaging properties of CT give insight into the 3-D movement of the proximal ulnar segment in response to UO. In a prospective clinical study on 10 dogs (12 elbows) with $\geq 2\text{mm}$ RUI + FCP and/or OCD, non-load-bearing CT was used before and 12 weeks after dynamic proximal ulnar osteotomy (DPUO) + ILR to evaluate movement of the proximal ulnar segment.¹¹ They found that distal axial translation of the proximal ulnar does not occur; instead there is a 3D rotation of the proximal ulnar segment. This complex 3D movement of the proximal ulnar segment reduced RUI at the MCP and increased RUI at LCP. They proposed that opening of the RU incisure space at the LCP may be attributed to the pull of the BBC insertion on the ulna and, therefore, this movement may be altered by concurrent BBC tenotomy/release. **Osteotomy Configuration** - Ulnar osteotomy can be transverse or oblique in configuration. Some surgeons opted to perform a caudo-proximal to cranio-distal oblique osteotomy in order to control caudal tipping of the proximal ulnar segment seen with transverse osteotomies. While Preston, et al showed that intramedullary stabilization of a transverse PUO could mitigate caudal tipping and varus angulation of the proximal ulnar segment, others theorized that a bi-oblique configuration to the osteotomy (caudo-proximo-lateral to cranio-disto-medial) would limit varus angulation of the proximal ulnar segment while being less restrictive than IM pin fixation.¹² Interestingly, amongst 12 DPUO studied by Böttcher et al (described above), there were 7 bi-oblique osteotomies (BODPUO) and 5 uni-planar oblique osteotomies (UODPUO); they found that varus deformity of the ulna more accentuated with UODPUO whereas it was effectively limited by the BODPUO.¹¹ Similarly, others evaluated 26 elbows with non-load-bearing CT before and 12 weeks after BODPUO and found increased RU joint space at the MCP base, mid-coronoid level and LCP.¹³ This displacement indicated cranial rotation of MCP around the proximal radial epiphysis and limited caudal tipping of the distal end of the proximal ulnar segment. There was no significant change in axial RU “step” incongruity; rather, it modified transverse plane RU congruence, essentially uncoupling the ulna from the radial head and allowing divergence. None of the studies above specifically evaluated clinical outcome of the BODPUO as compared to other osteotomy configurations. **Corrective Fixations of Ulnar Osteotomies** - Several specially designed bone plates intended for various “corrective” fixations of the elbow joint have been introduced. **Proximal ulnar rotational osteotomy (PURO)** attempts to mimic the effect of supination of normal elbows (a caudal shift of peak contact pressures upon the MCP). Ex vivo biomechanical study of unpaired limbs from 12 dogs found that the PURO effectively displaced the MCP caudally and abaxially and shifted contact pressures toward the lateral compartment by decreasing humero-radial varus angulation.¹⁴ **Proximal abducting ulnar osteotomy (PAUL)** is theorized to impose corrective alignment of the distal limb, aimed at unloading the medial joint compartment. A recent in vitro study showed decreased mean and peak contact pressures when PAUL was performed on limbs with induced +RUI; interestingly, the loads did not shift to the lateral compartment and

investigators questioned whether increased loading may occur elsewhere in the joint.¹⁵ Investigators also emphasized that their study was unable to elucidate if the load-shifting effects of the procedure were due to the plate fixation or the osteotomy itself in that the effects were very similar to those noted in a previous study of a proximal ulnar osteotomy with IM pin fixation.¹⁶

An algorithmic approach to MCPD therapy has been proposed based upon its varied manifestations.¹⁷ Results of such an algorithmic arthroscopic treatment approach to 23 elbows (frag excision, SCO w cartilage erosion > 3 + apex incongruity and/or large apical fragment, DPUO with RUI \geq 2mm at base) were recently reported.¹⁸ They found presenting lameness was more severe and initial gait analysis improvement greater with incongruent elbows and/or severe cartilage disease, but these factors did not affect long-term outcome. There was some evidence for improvement in long-term outcome with this algorithmic treatment approach.

Clearly, no single treatment is indicated for all the recognized manifestations of MCPD. Rather, a thoughtful, algorithmic, individualized care approach based upon our current best understanding of MCPD etiopathogenesis and the utility and limitations of available diagnostic tests is prudent.

Osteochondritis Dissecans (OCD) of the Humeral Trochlea

Treatment of OCD of the humeral trochlea carries a more guarded prognosis for return of normal or near-normal function than does OCD of the humeral head; this likely relates to differences in load applied (compressive vs. shear) and regional redistribution of those loads following fragment removal. Cartilage flap removal, curettage of the cartilage rim of the defect and micropick/forage treatment of the defect bed, as for the shoulder joint, are the mainstays of treatment for the elbow in most patients. The varied response to this treatment approach has stimulated interest in techniques that seek to restore joint surface integrity including autogenous transfer of osteochondral plugs harvested from the stifle joint. Preliminary results show some promise for this approach, but precise topographical matching of the plug surface to that of the surrounding cartilage surface remains a challenge for the very complex elbow joint.¹⁹ Donor site morbidity from a formerly healthy joint remains a potential concern. Use of osteochondral allografts harvested from healthy elbow joints of client-owned dogs euthanized for reasons unrelated to oncology or infection is an alternative technique. Since the donor plug is harvested from the same anatomic site as the recipient lesion (orthotopic transplantation), the donor plug may be larger and permit improved topographical matching of the cartilage surface.²⁰ Use of synthetic plugs is another alternative.²¹ One challenge inherent to each of these resurfacing options is obtaining adequate surgical exposure to permit proper angulation of drilling and plug delivery without excessive disruption of elbow joint stability. There is a paucity of peer-reviewed, controlled studies of outcomes for any of the above treatments for OCD of the humeral trochlea.

Un-United Anconeal Process (UAP)

Several surgical techniques have been described for treatment of UAP. Lag screw fixation of the UAP fragment, originally described by Herron in 1970, developed a reputation of high failure rates (failed union and screw breakage) and should

probably be avoided. Simple fragment removal often results in significant short-term improvement in patient comfort and function, though progressive osteoarthritis and associated morbidity are the predictable long-term sequelae. Proximal ulnar osteotomy was first described by Olsson in 1990.²² This relatively simple treatment was based upon the assumption that elbow incongruity resulting from a shortened ulna relative to the radius (*negative* radioulnar incongruence) places excessive stress on the anconeal process thereby preventing normal union. It was theorized that osteotomy would permit the triceps to proximally displace the proximal segment such that decreased stress on anconeal process would permit bony union. In reality, the displacement of the proximal ulnar segment is a more complex 3-dimensional tilting that is influenced by variations in that surgical technique that include osteotomy vs. ostectomy, transverse vs. oblique osteotomy and intramedullary pin fixation vs. no fixation. While the initial reports of ulnar osteotomy were very promising,²³ subsequent reports failed to achieve such high union rates²⁴ and a combination of ulnar osteotomy and UAP fixation was proposed for highly unstable fragments.²⁵ Either way, the pet owner must be prepared that some patients will apparently develop a functional union and symptomatic improvement though radiographic union is incomplete.²⁶ Ulnar osteotomy may not be indicated for patients with normal elbow congruence, but this has not been established. Similarly, attempts to accomplish bony union of the UAP may not be warranted in older dogs and/or dogs with significant elbow osteoarthritis; in these dogs, UAP excision is recommended.

Surgical Treatment of Cartilage Erosion of the Medial Elbow Compartment

Any combination of MCPD, OCD and UAP can lead to severe degeneration and even loss of cartilage in the medial compartment of the elbow (medial coronoid process, humeral trochlea, medial facet of the proximal articular surface of the radius and medial face of the ulnar trochlear notch). Many of these elbows have relatively healthy cartilage in the lateral compartment such that procedures have been developed in effort to shift total joint loads away from the medial compartment and toward the lateral compartment. Sliding humeral osteotomy (SHO),²⁷ proximal abducting ulnar osteotomy (PAUL),²⁸ proximal ulnar rotating osteotomy (PURO),¹⁴ external rotational humeral osteotomy (ERHO)²⁹ and canine elbow realignment osteotomy (CERO)³⁰ have all been theorized to achieve the desired lateral load-shift, but robust clinical data to support the efficacy of these procedures is lacking. Uncontrolled studies report of clinical efficacy exist for SHO, PAUL and CUE. Canine unicompartamental elbow (CUE)^{31,32} reduces bone on bone contact in the medial compartment by implanting a 4-6mm polyethylene plug into the cartilage eroded MCP and a cobalt chrome 'snowman' shaped plug into the opposing surface of the humeral trochlea. This arthroplasty may favor a shift of loading to the lateral compartment since the humeral implant is slightly proud to the surround cartilage at its center.

Lifelong Joint Support

While surgical treatment may well slow the progression of osteoarthritis in many dysplastic elbow joints, it is never curative. Therefore, lifelong joint support is indicated. Patients should attain and maintain a lean body conformation through proper nutritional management. Use of a prescription calorie restricted diet such as Purina Pro Plan Veterinary Diets OM can help ensure that the patient loses weight

at the desired rate of 1-2% of body weight per week while still receiving the necessary macronutrients, such as protein, to help preserve muscle mass. Evidence-based omega-3 fatty acid enhanced diets such as Purina Pro Plan Veterinary Diets JM have demonstrated efficacy in the clinical management of osteoarthritis. Physical rehabilitation can be used to build muscle strength, improve motor control of the limbs, address maladaptive gait patterns, maximize joint range of motion and to foster the weight loss plan as appropriate. The patient should adopt an active lifestyle that is moderated away from activities that promote lameness, stiffness and discomfort. Intramuscular injections of polysulfated glycosaminoglycans (Adequan®) and/or daily supplementation with a high quality glucosamine/chondroitin sulfate/ASU supplement (Dasuquin®) is often recommended. Intra-articular injection triamcinolone, hyaluronic acid, platelet rich plasma or stem cells are sometimes advised when more conventional means of OA management are deemed inadequate.

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Radiological Investigation of Dogs Suspect of Elbow Dysplasia

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Veterinarians need to be proficient in interpreting elbow radiographs so as not to miss a lameness due to elbow dysplasia in their patients. The general practitioner is the front-line care provider who will be able to obtain and interpret elbow radiographs and interpret them accurately for the dog and the owner. Accurate interpretation requires knowing where to look, what to look for and that even mild abnormalities are critical to recognize. Despite the long existence of the IEWG, elbow dysplasia is still being missed and is evidence that continuing education on image interpretation of the elbow is important to learn and refresh as much as possible.

Interpretation begins with obtaining diagnostic images. Although the mediolateral flexed image is the minimal requirement for elbow grading, additional images are helpful, if not crucial, for a complete assessment. Furthermore, when radiographic findings are equivocal in a clinical elbow lameness, more sensitive tests like CT may be warranted. Mediolateral extended, and ML flexed and craniocaudal (Cr15°LCdMO) views are most commonly used to assess the elbow. Radiographs are scrutinized for primary and secondary lesions. The primary lesions are: medial coronoid disease, ununited anconeal process, incongruity and osteochondrosis. Secondary disease is recognized by the presence of osteoarthritis. OFA and IEWG grades are based largely on the presence of osteoarthritis. The flexed mediolateral image is relied upon for identifying osteophytosis of the anconeal process, a secondary disease finding in ED.

Medial Coronoid Disease

Disease of the medial coronoid process is best seen on the ML extended and Cr15°LCdMO views. Separated fragments (FCP), blunting of the craniomedial border of the MCP, absence of the MCP, trochlear notch sclerosis and joint incongruity are signs of MCD. Blurring of the medial coronoid process cranial edge and ulnar trochlear notch sclerosis are reliable signs of elbow dysplasia and may be beneficial in screening protocols.

Ununited Anconeal Process

The UAP is best seen on the ML flexed view. There is generally an irregularly marginated gap between the anconeal process and the olecranon. The margins and surrounding bone are often sclerotic and can have osteophytes. Joint incongruity is also commonly seen.

Osteochondrosis

OC is best seen on the ML, Cr15°LCdMO, ML extended and ML flexed views. An articular margin lucency is present at the distal border of the medial humeral condyle, possibly with a sclerotic rim. It is uncommon to see a mineralized flap. Flattening of the condylar articular border can also be present. Kissing lesions of the humeral condylar border are often present with FCP but are more lateral than an OC lesion and often develop with chronic ED.

Incongruity

Incongruity of the humeroulnar joint is best seen on the ML extended view. A step between the lateral coronoid process and radial head and a more proximally positioned MCP, asymmetry of the humeroulnar joint space, widened humeroradial joint, indistinct border of the trochlear notch, and cranial displacement of the humerus.

Osteoarthritis

OA can be identified on all elbow views, but the ML flexed has been found most sensitive for osteophytosis of the anconeal process. Additional sites of osteophytosis include: cranioproximal border of the radial head, proximomedial border of the MCP, lateral border of the humeral epicondyle, and sclerosis of the base of the MCP (ulna, ulnar notch). Grading of the ED is based on the degree of anconeal osteochondrosis height; Grade 1: <2mm; Grade 2: 2-5mm; Grade 3: >5mm. Primary pathology is noted in addition to osteophytosis in the ED grading scheme.

Use of Computed Tomography

CT may be more sensitive (reported up to 93.8%) for identifying medial compartment disease such as MCP fissures and fragmentation as well as subchondral sclerosis and shape of the MCP compared with radiography. This is likely most important for grade 0 and 1 elbows. For elbow grades 0 or 1 in a cohort of 46 dogs, CT has shown 62% with grade 0 to have ED, and 75% of grade 1, suggesting that ED can be missed on radiographs (Kunst 2014). All dogs in that cohort progressed to have OA after 1 year, in both groups. Proliferation of bone at the anconeal process may not be osteophytosis due to ED in all dogs and CT would be an important test to confirm ED when this is the only radiographic sign present. The use of CT is still under investigation as a screening tool for ED compared to radiography. CT can identify MCP fissure and fragmentation, subchondral sclerosis, osteophytosis, incongruity, radial incisure cyst-like lesions and OC lesions. In a study of 31 dogs, ulnar subtrochlear sclerosis was the most common radiographic findings in Labrador Retrievers less than 1 year of age and blurring of the cranial edge of the MCP was most common in dogs greater than 1 year of age. MCP fragmentation was the most common CT findings in all age groups.

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Screening for Elbow Dysplasia, grading according to the IEWG

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Introduction

To learn from the variety of screening procedures as developed around the control of hip status for hip dysplasia, the International Elbow Working Group tried soon after its funding to come with one generally accepted screening of elbow joints for elbow dysplasia. The starting points were a practical method with a high sensitivity to detect all primary diseases of the elbow joint and to score the secondary osteophytes. In different breeds, different distribution patterns of primary, hereditary disease of the elbow joint were reported in 2014 by Lavrijsen et al.: In Labradors 94.8% was due to Fragmented Coronoid Process (FCP), in almost 10% of these cases including Osteochondritis dissecans (OCD), in Golden Retrievers the percentage FCP was comparable but the cases with OCD was almost 20%, the Bernese Mountain dogs had mainly FCP in almost half of the cases coincided with elbow incongruity (INC), whereas Newfoundlands revealed mainly FCP, some complicated with OCD, INC or an ununited anconeal process (UAP).

Primary diseases	Total population	Labrador Retriever	Golden Retriever	Bernese Mt. Dog	Newfoundland
OA without primary disease	4.1	2.9	6.0	1.8	5.0
only OCD	0.9	2.3	2.4		
only FCP	68.0	81.0	65.5	48.2	73.9
only UAP	0.6				0.8
only INC	0.6			2.4	
FCP & OCD	7.7	8.6	16.7	1.2	10.9
FCP & UAP	0.7				0.8
FCP & INC	15.8	4.0	4.8	45.3	8.4
FCP & INC & OCD	1.4	1.1	4.8	1.2	
FCP & INC & UAP	0.1				
FCP & INC & UAP & OCD	0.1				
OCD	10.1	12.1	23.8	2.4	10.9
FCP	93.8	94.8	91.7	95.9	94.1
UAP	1.5				1.7
INC	18.0	5.2	9.5	48.8	8.4
Total population size	9788	3333	1503	1221	622
Number of cases	868	174	84	170	119
Percentage of cases (%)	8.9	5.2	5.6	13.9	19.1

Table 1. Distribution of primary disease encompassing ED; overall (total of screened dogs, n=9788) and for Labrador (n=3333) and Golden retriever(n=1503), Bernese Mountain dogs(n=1221) and Newfoundlands (n=622) as % of the total number of cases of that breed. (from Lavrijsen et al 2014)

However, in some countries it was decided already to limit the amount of radiographs per elbow joint to one (mediolateral) view, allowing to score the originally called elbow dysplasia (i.e., ununited anconeal process; Carlson et al, 1961) and secondary signs of osteoarthritis (OA), this despite the fact that in the human and veterinary radiology two orthogonal views are considered minimal (Lappalainen, 2011). Based on a large body of publications on comparative studies and on experiences by specialized radiologists (Rau et al, 2011), the most sensitive projections and the precise technical advises to detect primary signs and secondary

osteophytes have been developed. Since international traffic of breeding dogs in common place, the dog world is interested in commonly accepted, uniformly reported grading of elbow status; because that is not always the case, an international ED-certificate has been presented, making transparent on which basis (which views, which screening authority) the judging has been given, to overcome the paradox that it stays unnoticeable for the breeders involved that the less sensitive screening is leading to the best score and thus to the most valuable dog. A copy of this certificate is given, but first some technical advices and the scoring according to IEWG guidelines is discussed. The interested reader is referred to the IEWG proceedings web page to read the original text of Prof. M. Flückiger and of Dr. B. Tellhelm in the proceedings of 2011 (<http://www.vet-iewg.org/wp-content/uploads/2017/02/proceedings2011iewg.pdf>).

Technical aspects

The minimal age when radiographs are made for ED-screening is at least 12 months, however in some countries (OFA, USA) the minimal age is set on 24 months, and in some European countries for giant breed dogs on 18 months (FCI), this in analogy with the minimal age for hip screening for giant breed dogs.

Some breeder clubs like to receive the diagnosis of the primary lesions of patient dogs with elbow lameness, this irrespective of the age of the dog so also of immature dogs, this particularly to include ED-positives in their statistics and breeding policy. The radiograph should include the identification of the dog (registration number or name of dog) and date of radiological investigation. In some countries also the name of the owner and of the veterinary clinic should be marked on the radiograph. The elbow is placed on the cassette / dedector, without grid.

In most countries a mediolateral projection (ML) with the elbow flexed with 45-60° opening angle between humerus and radius is required; it is important that there is a concentric superimposition of the lateral and medial part of the humeral condyle on the film. A more extended elbow joint (100-120°) can give a better impression for joint incongruity and outline of the coronoid process. An additional view, i.e., a ML view with the limb extended and 15° supinated, can give a better impression of the medial coronoid process, according to Voorhout et al, (1987).

A craniocaudal view (Fig.1) and/or a craniocaudal 15° pronated (Fig.2) with an extended elbow joint, is strongly recommended for a complete elbow evaluation on primary and secondary signs, i.e., to identify the medial humeral condyle for (1) indentation of the subchondral bone in case of OC, OCD, or kissing lesions, and for (2) grading at the 'f' and 'g' location of the IEWG score, respectively. The latter has revealed to be the most frequently found sign of OA in elbow screening (Lavrijsen et al, 2012). The position of the olecranon on the film is an important landmark (in the middle of the humerus super positioning the supertrochlear foramen on the AP (Fig. 1), and the olecranon not crossing the lateral cortex of the humerus on the APMO view (Fig. 2). The IEWG protocol allows for registration of the grade of OA alone, but for breeding measures and since the knowledge that OA can be absent on a considerable amount of cases of ED, at least two orthogonal views are preferable. Rau et al (2011) demonstrated that experienced radiologists, scored results of judgement of 3 views (ML extended and flexed, and the APMO view) for diagnosing ED, almost as good as computed tomography of the elbow joints.

The procedure

Radiographs of good quality and position are screened for elbow disease by competent and qualified persons (preferably ECVDI/ECVS or ACVR/ACVS diplomates) (Rau et al, 2011), when screened by a panel, then the majority determines the final score. The procedure should include the appeal procedure regarding film quality (the veterinarian) or the scoring (the owner/breeder) prior to or after release of the scorings results. Appeal procedures may warrant additional radiographs or computed tomography (CT) of the elbow joints. Results of the evaluation should be open to researchers, dog owners and breeders with respect to the privacy regulations. Radiographs must be archived at an appropriate location for 10 years.

Films are evaluated in a two-stage process: 1st assessing the degree of secondary osteoarthritis, and 2nd checking for signs of a primary lesion including ununited anconeal process (UAP), osteochondrosis or osteochondritis dissecans (OC(D)), abnormal medial coronoid process (MCP), and elbow incongruity (INC). Any other abnormal finding can also be registered. (Fig. 3)

The score

The radiological findings of the elbow joints are according to the severity (size) of the presence of osteophytes and/or the presence of abnormalities reflecting the primary lesions (Ununited Anconeal Process (UAP), Osteochondritis Dissecans or Osteochondrosis (OC(D)), Fragmented Coronoid Process (FCP) or Medial Coronoid Disease (MCD) and/or elbow joint incongruity (INC) according to the IEWG update in 2010 (see proceedings, IEWG 2011)

Grade	Description	Radiological findings
0	Normal elbow joint	Normal elbow joint, No evidence of incongruity, sclerosis or arthrosis
Borderline •		
1	Mild arthrosis	Presence of osteophytes < 2 mm, sclerosis of the base of the coronoid processes - trabecular pattern still visible
2	Moderate arthrosis or suspect primary lesion	Presence of osteophytes 2 - 5 mm Obvious sclerosis (no trabecular pattern) of the base of the coronoid processes Step of 3-5 mm between radius and ulna (INC) Indirect signs for other primary lesion (UAP, FCP/medial Coronoid disease (MCD), OCD)
3	Severe arthrosis or evident primary lesion	Presence of osteophytes > 5 mm Step of > 5 mm between radius and ulna (obvious INC) Obvious presence of a primary lesion (UAP, FCP/CD, OCD)

• Borderline

A borderline (BL) sub-scoring between ED 0 and ED 1 is used in some countries. It is defined as minimal modelling of the anconeal process (dorsal contour) of undetermined aetiology (Tellhelm, 2011)



Fig. 1 The scorings locations according to IEWG scorings system are indicated on the mediolateral (ML) and the craniocaudal (CrCd) view.

Interpretation of the ML views

- a. New bone formation at the dorsal edge of and laterally on the anconeal process, visible at the extended and/or at the flexed view (only at the dorsal margin can be an anatomical ridge, not reflecting osteophytosis; Lappalainen et al, 2009).
- b. New bone formation at the cranial edge of the radius, (not overlapping the cranial part of the humeral condyle)
- c. Indistinct and/or deformed contour of the medial coronoid process or an irregular / reduce bone opacity of the medial coronoid process (a fragment is rarely seen, a sesamoid bone can be noticed)
- d. New bone formation at the medial condylar ridge of the humeral condyle
- e. Increased subchondral bony opacity (sclerosis) in distal part of semilunar notch, and loss of trabecular pattern. (The size of the sclerotic area as well as its intensity determine if the sclerosis has to be considered as pathological. Sclerosis is not present in all cases of ED, e.g. it is rarely noted in German Shepherds with FCP)



Fig.2 *The projection of the tip of the olecranon should not pass the lateral cortex of the humerus of the extended elbow joint for the proper APMO view. This view allows for inspection of the location of the indentation (“h” on IEWG scoring form) in case of OC(D) and “kissing lesion”, and for osteophytosis at the medial side of the humerus and ulna (“f and “g”, respectively)*

Interpretation of the AP(MO) views

- f and g. new bone formation at the medial humeral epicondyle and medial coronoid process (Fig.1&2)
- h. indentation in the subchondral contour of the medial aspect of the humeral condyle. (Fig.1, arrow, Fig.2)

Primary signs of ED visible on the ML view(s)

- Medial coronoid disease (MCD), fragmented medial coronoid process (FCP), Ununited Anconeal process (UAP), partially ununited or completely loose with or without dislocation
- Incongruity/step between radius and ulna (INC), uneven joint space width between humerus and radius.
- In selected cases (quality of the radiograph, size of the lesion, experience of the interpreters)
- Osteochondritis (Dissecans) at the medial humeral condyle

The following findings can indicate an abnormality in the fusion of the secondary ossification center of the anconeal process and is considered as a grade ED2 abnormality: Irregular radiolucent vertical line between anconeal process and ulna still present after 18 weeks of age, an incomplete fusion resulting in a patchy irregular mineralized anconeal process, irregular subchondral sclerosis, progressive OA depending on the duration of process.

Primary signs of ED visible on the AP(MO) view

Osteochondritis (dissecans) and kissing lesion at the medial humeral condyle
Step between radius and ulna in the elbow joint, fragment at the top of MCP

Until DNA-screening techniques for screening different entities of ED in different breeds are developed, breeders can make use of sophisticated and non-invasive imaging techniques, although it may still include a certain percentage of false negatives. At this time no reliable method to identify a genomic breed value in polygenetic diseases exists. The most practical technique until now is making and screening radiographs together with open registration of results, offspring control, and consequent implementation of the results in breeding programs. The feasibility of performing genetic evaluation of HD across countries (Sweden, France and the UK) was indicated by the favorable genetic correlations estimated between score modes. The authors concluded that “the type of HD scoring varies across countries, which is a potential weakness for the implementation of international evaluation of HD and it may impact genetic correlations between countries” (Wang et al, 2017). The efforts of the IEWG to uniform the grading for ED based preferably on at least 2 orthogonal views will overcome such a weakness. In orthopaedic practices more sophisticated techniques including bone scintigraphy and CT-scanning, or more invasive techniques as arthroscopy or arthrotomy are performed (Gielen, 2018). In clinical practice CT has proven its value that it may be possible to register primary diseases in the elbow joint which might be hidden on standard radiographs. For that reason, some ED-scoring committees offer the possibility to owners to hand over a digital copy of the CT-investigation of the elbow joint, in case of appeal. At recent meetings of the IEWG, a first IEWG CT screenings protocol with scorings list has been accepted. The interested reader is invited to visit the IEWG web page and read the proceedings text of in the proceedings of 2018, Barcelona meeting, regarding the CT-protocol as presented by Dr von Pückler.

Till DNA-screening techniques are developed, the veterinary profession has to uniform the screening methods to solve the paradox that the better the screening, the more likely to be graded positive, and thus the greater the chance to be excluded from breeding and the harder to sell the dog or its offspring. Certification should at least make the way and quality of screening transparent and IEWG likes to assist the veterinary profession in this. (Fig. 3). Veterinarians associated with the WSAVA are in the strong position to implement the certificate as has been designed for dog owners when dogs are sold within or outside the country, to offer insight to the potential buyer if the animal has been tested and if so, according to which protocol (Hazewinkel, 2006).

Fig 3. The IEWG certificate for radiological investigation of the elbow joints.

IEWG or WSAVA

Certificate of radiological Elbow Dysplasia examination

Examination based on International Elbow Working Group Standards

Archieve and Registration for Great Britain

Logo Kennel Club

Etc..Etc..

Registration nr. Examination

ED-GB

National reg. veterinarian reg. nr. examiner

Animal

Name

Breed

Registration nr Tattoo

Microchip nr

Date of birth day month year Sex F (female intact) FS (female spayed) M (male intact) MC (male castrated)

Owner/agent

Name

Address

Country, Zip Town

The undersigned agrees to the WSAVA/IEWG examination protocol, the rules of the national scheme and confirms that the dog submitted for examination is the one described above. Signature also means that the results are available for official publication.

Signature owner / agent

Examination (veterinarian, age of dog, radiologic views)

Veterinarian

Name

Address

Country, Zip Town

Identification of dog

Check tattoo Correct Partly/unreadable Incorrect Absent

Check microchip Correct Incorrect Absent

Radiologic examination

Date radiologic examination day month year Age Year Months

Number of radiographs per elbow 1 2 3 4 5

Radiologic projections ML-flexed (Medio-Lateral 45°-flexed) CC (Cranio-caudaal) CC-15° pronated (Cranio-caudaal-15° pronated) ML-neutral (Medio-Lateral 90°-ext.) ML-extended (Medio-Lateral >120°ext.) Other: (specify)

The undersigned agrees that the examination is performed according to protocols of the WSAVA (World Small Animal Veterinary Association) and her affiliate, IEWG (International Elbow Working Group). Furthermore the undersigned states that the dog, submitted for IEWG-elbow-examination is the above mentioned dog. The results will be registered and archived by the National Kennel Club

Signature veterinarian

Results evaluation by National ED-panel

Veterinarian

Name

Address

Country, Zip Town

Radiographic evaluation

Date panel evaluation day month year

	Left elbow					Right elbow				
Primary lesion	UAP	FCP	OC	INC	Other	UAP	FCP	OC	INC	Other
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	← Affected →					← Suspected →				
	(No definite proof of a primary lesion) Free					(No sign of secondary arthrosis) Grade 0				
Secondary arthrosis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Borderline					Grade I				
	<input type="checkbox"/>					<input type="checkbox"/>				
	<input type="checkbox"/>					<input type="checkbox"/>				
	<input type="checkbox"/>					<input type="checkbox"/>				
	<input type="checkbox"/>					<input type="checkbox"/>				

The undersigned agrees that the radiographic evaluation is performed according to protocols of the WSAVA (World Small Animal Veterinary Association) and her affiliate, IEWG (International Elbow Working Group).

Signature authorized examiner

Interpretation

Interpretation based on the current recommendations of the International Elbow Working Group (IEWG), an affiliate of the World Small Animal Veterinary Association (WSAVA)

Primary Lesions
 UAP Ununited Anconeal Process
 FCP Fragmented Coronoid Process
 OC Osteochondrosis or Osteochondritis dissecans of the medial humeral condyle
 INC Incongruency of more than 2mm between articular surface of Radius and Ulna
 Other Lesions Avulsion medial humeral epicondyle
 Mineralisation medial collateral ligament/origin flexor muscles
 Other:

ED grade, based on the secondary arthrosis © IEWG e.v.
Grade 0 No signs of arthrosis
BL Border Line: Undetermined changes
Grade 1 Osteophyte formation of less than 2 mm anywhere in the elbow joint
Grade 2 Osteophyte formation of 2-5 mm anywhere in the elbow joint
Grade 3 Osteophyte formation of more than 5 mm anywhere in the elbow joint

Note: The classification Grade 0 (or no detected primary lesion) does not imply that the animal is genetically sound. Based on the current scientific knowledge IEWG does not recommend breeding of arthrotic animals or animals displaying a primary lesion!

Space for sponsors !!!

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International Elbow Working Group

The International Elbow Working Group [IEWG] was founded in 1989 by a small group of canine elbow experts from the USA and Europe to provide for dissemination of elbow information and to develop a protocol for screening that would be acceptable to the international scientific community and breeders.

The annual meeting is organized for the purpose of exchanging information and reviewing the Protocol. All interested persons are invited to attend the meeting and to participate in its activities.

The IEWG is an affiliate of the WSAVA.

IEWG meetings were held in

Davis	1989
San Francisco	1990
Vienna	1991
Rome	1992
Berlin	1993
Philadelphia	1994
Konstanz	1995
Jeruzalem [cancelled]	1996
Birmingham	1997
Bologna	1998
Orlando	1999
Amsterdam	2000
Vancouver	2001
Granada	2002
Estoril	2003
Bangkok	2003
Rhodes	2004
Amsterdam	2005
Mexico	2005
Munich	2005
Prague	2006
Munich	2007
Dublin	2008
Sao Paulo	2009
Bologna	2010
Amsterdam	2011
Birmingham	2012
Cape Town	2014
Bangkok	2015
Vienna	2016
Verona	2017
Barcelona	2018

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