PROCEEDINGS

13th annual meeting of the

INTERNATIONAL ELBOW WORKING GROUP

Wednesday October 2nd, 2002
Granada, Spain

Welcome address from Prof. Herman A.W. Hazewinkel president of IEWG

Dear congress participants,

We welcome you at the 2002 meeting of the International Elbow Working Group (IEWG).
Last year, the Vancouver meeting was organized by Paul W. Poulos, one of founders of IEWG. Dr Poulos, radiologist and bone pathologist, was most dedicated to study radiologically skeletal developmental diseases both as a scientist and, in recent years, as a reader of radiographs for screening hereditary skeletal diseases. For many years Dr Poulos was, as part of the Californian-quartet with Dr Lida Wind and Dr.& Mrs Packard, one of the initiators of IEWG and he initiated IEWG to become affiliate member of the World Small Animal Veterinary Association (WSAVA). The quartet deserves the acknowledgments of the present members of the IEWG for all the work they did during the past decade for IEWG and the goals they accomplished. As a result of that, IEWG is invited to organize its meeting during the pre-congress day, preceding the annual WSAVA-congresses allowing IEWG to fulfil one of its main purposes, i.e., bringing a variety of practical aspects on elbow dysplasia under the attention of veterinarians in order to refine its diagnostic procedures, to educate the newest on its medical and surgical treatment, and to discuss its etiology and prevention. The latter includes hereditary measures to be taken by breeders and kennel clubs and guided by veterinarians, as well as to optimize environmental conditions including nutrition and life style.
An other purpose of IEWG is to get an international certificate on elbow dysplasia accepted by the international veterinary community, declaring the status of the elbow joints of a particular dog and the screening methods where the judgement was based upon, thus providing transparent and valuable information to breeders and new owners.
The board of the IEWG is grateful to IAMS Europe and Pfizer Company for their interest in the goals of IEWG and their involvement in the battle against the disabling consequence of elbow dysplasia. Due to the financial support of Iams Europe and Pfizer Company the IEWG is able to organize a meeting with all aspects on elbow dysplasia of interest for the practicing veterinarian, presented by a team of well-known and experienced specialists in their field. In addition, the board thanks Dr. Olga Cortes (Iams) for providing projection equipment during the lectures, Dr. Floris de Haan for equipment to use during the breaks to discuss radiographs of elbow joints with participants, Dr. Jose Marin for his help in logistics at the scene in Granada, and the organizers of the WSAVA/FECAVA/AVEPA congress for their hospitality.
We are looking forward to your membership of the IEWG to support IEWG in fulfilling its obligations, and to stay informed about the developments on elbow dysplasia in the years to come. In addition, we welcome you to visit the web page of IEWG -updated by Dr Packard at a regular basis- to keep posted on future meetings including the IEWG-meetings in 2003 in Bangkok and Lisbon, and in 2004 in Rhodos. The web page address is: www.vetmed.ucdavis.edu/iewg/iewg.html
Also on behalf of IEWG's secretary Dr. K.L. How and its treasurer Dr. B. Tellhelm, I wish you a fruitful meeting in Granada.

Dr. H.A.W. Hazewinkel
President IEWG

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and

Pfizer Animal Health

PROGRAMME IEWG 2002 MEETING

Wednesday October 2, 2002

8.00-9.00	Registration
9.00-9.20	The development of the trabecular structure of the medial coronoid process in retrievers C.F. Wolschrijn
9.25-9.55	The clinical diagnosis of elbow dysplasia H.A.W. Hazewinkel
10.00-10.30	Breeding and feeding for elbow conformity .A. Hedhammer
10.30-11.00	Arthroscopy of the elbow to diagnose and treat FCP and OCD in dogs J.F. Bardet
	Break and poster session
11.00-11.45	Arthroscopy of the elbow to diagnose and treat FCP and OCD in dogs M. Flückiger
12.15-12.30	General discussion
12.30-14.00	Working lunch, poster session & X-ray screening
14.00-14.30	Surgical therapy of elbow dysplasia: technique and follow up A. Vezzoni
14.30-15.00	The IEWG Screening Protocol for Elbowdysplasia; some critical remarks with special stress to breeding aspects B. Tellhelm
15.00-16.00	Free communications
16.15-17.15	Business meeting IEWG (members only)

List of speakers

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32 Rue Pierret Neuilly sur Seine, 92200 France

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Radiographic diagnosis of elbow dysplasia (ED) in the dog

(Requirements for the internationally standardized screening procedure for ED)

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ED occurs predominantly in medium or larger breeds of dogs. Incidences range from 0% in Border Collies up to 48% in Chow Chows. Male dogs are more likely to br affected by ED than females, and 20-35% of dogs are affected in both elbows. First clinical symptoms may occur as early as 4 months of age. Dogs with ED may or may not be lame, therefore, using lameness to determine the presence of ED or the breed value of an animal is not reliable. The only feasible screening mode is based on radiographs.

Radiographic technique

1. Minimal international requirement is 1 mediolateral view of each elbow joint
2. Both elbows are radiographed
3. No grid is used (for mediolateral views), the limb is placed directly on the cassette
4. Mediolateral projection with elbow in flexed position (45° opening angle)
5. Medial and lateral humeral condyles overlap
6. The beam is collimated, which improves image resolution
7. Additional views such as mediolateral view in neutral position (approx. 110° opening angle) and craniocaudal view with 15° limb pronation (and 15° beam angulation in proximal direction, if possible) are strongly recommended
8. MCP is identified best on a caudomedial - craniolateral 15° oblique view, with the limb placed in lateral position, extended and 15° supinated
9. Minimal age is 12 months for routine screening, but radiographs can be taken at any age in dogs with signs of elbow lameness. Check breed-club specific requirements!
10. Radiographs are fully and permanently identified
11. Radiograph will be archived at appropriate location for 10 years
12. Results of screening procedures are open to researchers and to public
13. A possibility for appeal prior to release of the results is provided

Interpretation

Radiographic findings vary depending on etiology, breed, severity, and age of the dog. The radiographic diagnosis of ED is based on presence of arthrosis and/or a primary lesion such as

- malformed or fragmented medial coronoid process, FCP
- ununited anconeal process, UAP
- osteochondrosis of the medial humeral condyle, OC/OCD
- massive incongruity of the articular surface (step, subluxation), INC

  Futher findings (of unknown etiology and relevance) may be calcification of periarticular tissue (flexor tendon or bursa of medial epicondyle)
- DJD resulting of unknown origin
- any other abnormality noted

FCP

Mediolateral radiograph

1. increased subchondral bony density in distal part of semilunar notch, with loss of trabecular pattern
2. step between radius and ulna
3. blurred cranial edge of medial coronoid process, but a FCP-fragment is rarely seen!
4. new bone formation dorsal and lateral to anconeal process, on cranial border of radius and of medial humeral condyle
5. uneven joint space width between humerus and radius.

Cranio-caudal radiograph:

6. bony irregularity and/or build up on the medial border of humerus and ulna, but visualisation of bony fragments is uncommon.
7. step between radial and ulnar subchondral bone plate
8. humeroradial joint space wider on medial side than on lateral, particularly in BMD
9. occasionally subchondral bone defect in the medial humeral condyle with/without subchondral sclerosis (OCD or kissing lesion), but a bony flap is rare.

Beware of artifact: The sagittally running radiolucent line within the MCP usually represents the edge of the ulna and not a fracture!

OC/OCD (Osteochondrosis, Osteochondritis dissecans)

DJD similar to FCP, but usually somewhat less pronounced. Typical findings are

1. defect in articular surface of medial humeral condyle, best seen either on the craniocaudal or mediolateral extended view
2. a bony fragment is rarely visible
3. defect may be missed when suboptimal technique is used!!

UAP (ununited anconeal process)

1. irregular radiolucent vertical line between anconeal process and ulna after 18 weeks of age
2. irregular subchondral sclerosis
3. progressive DJD depending on duration of process

Scoring

The elbow findings are scored according to severity of the arthrosis (DJD) and/or presence of a primary lesion using the IEWG (Int. Elbow Working Group) protocol

Elbow Dysplasia Grading		Radiographic Findings
0	normal elbow joint	normal elbow joint, no evidence of incongruency, sclerosis or arthrosis
I	mild arthrosis	sclerosis of ulnar trochlear notch or, step =/> 2 mm between radius and ulna or, osteophyte formation less than 2 mm high
II	moderate arthrosis	osteophyte formation 2 to 5 mm high
III	severe arthrosis or 1° ED	osteophyte formation over 5 mm high and / or primary ED such as LPA, FMCP, OCD

Differential diagnoses (probably incomplete)

Common
Panosteitis (Enostosis)
Less common
premature closure of a growth plate (usually distal ulna, traumatic in origin)
short ulna syndrome or elbow malformation in chondrodysplasic dogs without elbow disease (in Basset, Corgi, and other breed)
avulsion of flexor muscle origin at medial epicondyle
mineralisation of flexor origins
trauma induced elbow arthrosis
Rare
Osteomyelitis
septic arthritis
hypertrophic osteodystrophy
ununited humeral condyles
mineralisation of extensor muscle origin at lateral epicondyle
congenital elbow luxation with lateral displacement of the radial head

Literature

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi (Enter: Elbow dysplasia canine)
Morgan JP, Wind A, Davidson A: Hereditary bone and joint diseases in the dog, schlütersche 2000.

Breeding and feeding for elbow conformity

Professor Åke A Hedhammar, DVM, M. Sc.; PhD
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Over 30 years have elapsed since conditions affecting the elbow was recognised as clinical entities affecting large sized breeds of Dogs to great extent. We have learned quite a lot and agreed on several measures to be taken against it. That includes selection of breeding stock as well as feeding practices. There are still however gap in our knowledge, weaknesses in our approaches and things we miss to handle and advice professionally on how to enhance elbow conformity.

Although we have agreed on the term Elbow Dysplasia, it must be remembered that it is made up by several different entities, eventually but not necessarily, resulting in elbow arthrosis. As the different entities most likely have different genetic background and probably each influenced by many genes the genetic background is more complex than i.e. for hip dysplasia.

The prevalence of entities making up Elbow arthrosis in different breeds varies, calling for more breed specific measures. Crude measures suitable to handle elbow arthrosis in Bernese Mountain Dogs and Rotweilers does not necessarily serve the same purpose in the Retrievers. In German Shepherd the prevalence of Ununited Proc Anconeus calls for specific measures. The situation in countries with extensive screening of the entire population is in a different situation than those where barely the breeding stock is screened to any greater extent.

Even though there are experimental as well as epidemiological evidence for negative effects on elbow conformity by extensive feeding and excessive amounts of calcium, these studies are not specific enough to differentiate the effects on the different entities behind elbow dysplasia.

Despite an impressive and accelerating rate of publications within the field, there are still knowledge lacking. We also continuously need to re-evaluate guidance and measures taken based on present knowledge. Radiological techniques, genetic analyses as well as breeding and feeding advice must be based on solid scientific grounds.

In an ambition to evaluate breeding and feeding effects at the same time, we are at present in Uppsala looking at the impact of nutrition and physical activity on elbow arthrosis by a case control design within a birth cohort of Labrador retrievers with well defined genetic background and documented nutrient intake from birth to screening at one years of age.

The clinical diagnosis of elbow dysplasia

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Introduction
Elbow dysplasia (ED) is recognized by veterinarians and breeders as a serious problem for certain populations. Depending on the specific sub-population and the method of investigation, elbow dysplasia is seen in 46-50% of the Rottweilers, 36-70% of the Bernese Mountain Dogs, 12-14% of the Labradors, 20% of the Golden Retrievers, 30% of the Newfoundlanders, and 18-21% of the German Shepherds.
The success rate of surgical treatment of elbow dysplasia depends on the complete diagnosis before surgery, the correct surgical positioning and on atraumatic surgical approach as well as the careful aftercare by the owner. The rate of success in elimination of the ED from the population depends on the measures taken by breeders, breeder clubs, national and international kennel clubs based on the correct diagnosis and corresponding genetical analysis.
ED can be separated into different disease entities including ununited anconeal process (UAP), fragmented coronoid process (FCP), osteochondritis dissecans (OCD) of the medial humeral condyle and incongruities of the elbow joint (IE).
UAP, FCP, OCD and INC are all considered to be part of the osteochondrosis complex.. Osteochondrosis is a disturbance in the process of endochondral ossification of growth plates as well as of joint cartilage. The latter will become clinical evident in case fissure lines cause a cartilage flap, i.e., osteochondritis dissecans. Osteochondrosis is more often seen in males and faster growing females during the fastest growth phase of large (i.e., fast growing) breeds. It is seen in shoulder, elbow, stifle and hock joint most frequently. In certain breeds some manifestations of OCD are seen more frequently than others. An hereditary aspect will play a role in the occurrence of OCD in just that particular joint and localization (coronoid, anconeus, growth plate of radius or ulna). Inspection of the front and rear legs may demonstrate valgus deformation due to retained cartilage cones in the growth plates of ulna. Inspection and palpation of elbow, stifle and tibio-tarsal joints may demonstrate overfilling in case of OCD in these joints. Hyperextension or -flexion of these joints and/or of the shoulder joints (which can not be palpated for effusion!) may cause pain reaction in case of osteochondritis dissecans (not in case of osteochondrosis!).
Here the clinical invesigation of following topics will be discussed: the protocol for clinical diagnosis of UAP, FCP and OCD, 2) information on measurements to prevent the occurrence of ED.

Clinical investigation
The clinical investigation starts with registration of the breed and age of the dog (lameness starts at 4-10 months of age) and inspection of the dog in standing position; in almost 50% of the cases the paw of the affected leg is externally rotated and slightly abducted When walking and trotting, the head is lifted when the affected leg, or in case both front legs are affected the most painful leg, is weight bearing. On palpation, the elbow is effused. Effusion is usually more pronounced in case of UAP than in FCP or OCD. Effusion of the elbow joint is felt at the side of the anconeal muscle, but slight bulging of the muscle is physiological. With the dog in lateral recumbency, the range of motion (ROM) of the elbow joint is examined while the thumb is placed on the anconeal muscle to register crepitation; attention is payed when pain is evoked.

In case of a UAP, there is especially crepitation and pain sensation upon once a firm hyperextension of the joint. In case of FCP and/or OCD, crepitation and pain reaction can be provoked at prolonged hyperextension, and in particular when the radius and ulna are exorotated in relation to the humerus. This causes increased pressure at raio-ulnar joint and at the medial elbow region and thus pain sensation when pathology is present in that area.
Radiographs can be conclusive. On a mediolateral flexed (MLflexed) view, a dark area between anconeal process and olecranon will confirm the diagnosis in case bony union should be complete (i.e., the dog over 5-6 months of age). Sclerosis at the fracture site and osteophytes at the borders of the joint can be visible.
OCD lesions can best be registered on anterior posterior medial oblique (APMO) views, whereas on anteriorposterior (AP) views one third of the cases will be missed! For screening elbow joints on the presence of a FCP a variety of views is advocated, including the AP, APMO, MLflexed, MLextended and the ML with the joint extended plus the radius-ulna 15 degrees exorotated. We studied the value and additional value of each of the first four mentioned views where the complete set of four views served as a golden standard, and demonstrated the limited value of the MLflexed and the APMO as a sole view, but its great value as additional view in this respect. The false negatives of almost 20% when only MLflexed are used in a screening program for FCP, explains the difference in percentage of positive Bernese Mountain Dogs between countries. In addition, osteophytes and sclerosis of the semilunar notch are taken into account for making the diagnosis. Small osteophytes are especially visible on a combination of at least 3 or 4 of the mentioned views. In a fair amount of cases both UAP and FCP is bilateral present (30% and more than 50% of the cases, respectively) and therefore both elbow joints should be investigated, even in case of clinical unilateral complains.
In case no abnormalities are visibly the clinical investigation is re-evaluated to exclude differential diagnoses (i.e., OCD in the proximal humerus, panosteitis eosinophylica, fractures of sesamoid bones), and is the investigation repeated after 3-6 weeks. Auxiliary techniques (CT scanning, bone scanning, arthroscopy) when available, can be of value.
The correlation between radiographic signs of elbow dysplasia and physical signs depends on physical demands (working dogs vs. house pets), the severity of the lesions (FCP plus incongruity is more severe than FCP or incongruity alone, grade 1 arthrosis does not necessarily goes together with lameness), the age of onset of complains (lameness at young age is more severe), and breed. The clinical signs of a comparable coronoid lesion in Retrievers are more severe than in Rottweilers. Read et al reported in 1997 that 57% of a group of 55 Rottweilers in a prospective study developed radiological signs of FCP but “only”15% showed physical signs (joint effusion, pain and crepitation on movements) and 10% developed lameness.

IEWG

In 1989 a group of veterinary radiologists, geneticists and clinicians founded the International Elbow Working Group (IEWG) with annual meetings in the United States of America and in Europe. This IEWG accepted a scoring scheme for the evaluation of radiographs, based on the propositions of Audell, and are adopted by the Federation International Cynologique and the World Small Animal Veterinary Association and in different national kennel clubs. The protocol and additional information is available on the web side of the IEWG (www.vetmed.ucdavis.edu/iewg/iewg.html).
Although the scoring of arthrosis following the minimal guidelines of the IEWG are performed on the mediolateral flexed and anterioposterior views only, and thus underestimates the occurrence of the primary cause of elbow dysplasia including OCD, FCP and EI, it was decided during many meetings of the IEWG, that is certain circumstances this is the maximum which can be asked for.

In a few countries with a high density of veterinarians trained in making different views of elbow joints, national breeder and kennel clubs decided to use radiological screening for making the diagnosis of the cause of osteoarthrosis, rather than screening for the degree of osteoarthrosis. It is to the discretion of the breeders which criteria is of main interest: screening on osteoartrosis will include false negatives (since osteophytes needs time to develop, in some cases years) and false positives (not all cases of osteoarthrosis of elbow joints are due to ED), but it gives a far better insight that a survey send to and completed by (some) owners. The more views of good quality, the greater the chance to visualize the one or more of the causes of ED.
From the above it should be clear that ED has different forms, with a higher incidence in certain breeds than in others, whereas it is most likely that even the same form in different breeds (for example FCP in Labradors and Bernese Mountain Dogs) does not present themselves in the same way (clinically nor radiologically) and/or follow the same pattern of genetics (recessive or dominant with or without differing in penetration). Geneticists should be involved to plan a screenings programme, based on selection material provided by the radiologists and organized and payed by the responsible breeders.
By making the screening results available to all breeders, a considerable success in improving elbow status can be reached as is demonstrated to occur in Norway and Sweden as published by Grondalen and Swenson in Bernese Mountain Dogs, Rottweilers, Labrador Retrievers and German Shepherds.

Suggested reading
The interested veterinarian is strongly advised to visit the web page of the IEWG with the proceedings text of recent meetings and the screenings protocol for ED: www.vetmed.ucdavis.edu/iewg/iewg.html).

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The IEWG Screening Protocol for Elbowdysplasie; some critical remarks with special stress to breeding aspects

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The diagnosis of elbowdysplasia (ED) in screening of dog breeds is based on the evaluation of radiographs according to the protocol of the International Elbow Working Group (IEWG).
The most recent update of this protocol is available on the IEWG web site.

This protocol defines the radiological findings in “abnormal” elbows: the presence of arthrosis and/or the major forms of primary lesions (FCP, OCD, UAP, Incongruity). Any other abnormal findings should be also reported.
The degree of arthrosis in a joint is graded as either “normal” (Grade 0), mild (Grade 1), moderate (Grade 2) and severe (Grade 3). As someone who routinely uses with system, I have encountered several problems. An important decision one has to make is to differentiate between “normal” and “abnormal” joints. Frequently there are elbows with only minimal changes at only one site of the joint (mostly the dorsal border of the anconeal process). In many cases one can even not be sure that these findings are osteophytes representing signs of arthrosis. These joints are not “normal” and have to be scored as arthrosis grade 1. That may exclude those dogs from breeding. On the other hand we find elbows with osteophytes at several sites of the joint and close to 2 mm in size. Some of this even show findings which are suggestive for the presence of an FCP, but no fragment can be dedected. Although both joints have to be scored as grade 1, their radiological appearance is very different. Not only owners and breed clubs have problems with this - as a scrutineer I am also not happy with this state of affairs.
Therefore a “borderline grade” should be introduced, analogous to the screening of CHD. This is already planned in the draft of an international certificate created for WSAVA. So IEWG has to set the radiological criteria for a borderline grade.
Incongruity (INC) also is a finding that requires more precise definition if it is to be used for the classification of elbows.

In general, the IEWG screening protocol only allows classification in different grades of diseased elbows based on the degree of arthrosis. The term “ED” includes arthrosis and primary lesions. We have no protocol for grading ED comparable to CHD. But this is what most of the breed clubs want to have: a clear classification of ED including the primary lesions. So in practice in different countries primary lesions were scored in ED 2 ore ED 3 respectively. A recommendation of IEWG how to handle this would be helpful.

It may be that these issues are of minor importance for a breed club which has chosen mass selection to reduce frequency of ED. But in some breeds mass selection does not lead to a satisfactory improvement of the ED status. Heretability of ED scored on the basis of the IEWG protocol is not sufficiently high in some breeds to achieve an adequate response to selection.
Breeding value estimation (BVE) is a method to improve the results. However problems arise in the practical application of BVE problems if using the IEWG score as basis. First the primary lesions have to be included in the score as mentioned above.

But elbows/dogs can only be classified in 4 categories. Depending on the breed 50% to about 80% of the dogs have “normal” elbows and are scored as ED grade 0. On the other hand only few dogs were scored as ED 2 and ED 3. The small number of categories and their asymmetric distribution in the screened population makes it difficult to work with BVE.
So we have to think of other classification protocols for ED screening in addition to that currently proposed by IEWG. One variation is the use of a “point system” as published by Lang and coworkers last in 1998 (1).
A very different approach to the classification of elbows as a basis for BVE has been presented at the 2000 IEWG meeting in Amsterdam by Beuing and is now published as dissertation in Germany by Mues in 2001 (2). In Rottweilers different angles of the elbow joint were measured and out of the results a special index “EQ” (elbow quality) was constructed. The author found a high heritability of “EQ” and a high genetic correlation between this index and the results of scoring according to the IEWG protocol. So this method is suggested as a better alternative if application of BVE is planed in a breed club.

It should be the duty of IEWG to investigate such different screening protocols and give a recommendation to the breeders which one of several methods have a solid scientific basis.
They only should be used beside the (modified ?) IEWG protocol, because this allows a good comparison between the results of different readers in different countries.

References

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Surgical therapy of elbow displasia: technique and follow up *(preliminare report)*

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Introduction

Elbow dysplasia (ED) is a common clinical finding in growing dogs of several large breeds. Conservative treatment based on rest, NSADs and diet control can be indicated in mild cases, while in dogs with persistent lameness or more severe joint alterations surgical treatment can be recommended to reduce joint degeneration. Surgical treatment can be performed through a conventional surgical approach or through arthroscopy. Arthroscopy has the advantage of being diagnostic and operative at the same time and of being a mini invasive technique. Conventional surgical approach can be mini invasive too providing that a conservative anatomical approach is used and has the advantage of requiring inexpensive equipment compared to arthroscopy and a quicker learning curve that can extend surgical treatment to a wider number of surgeons. Purpose of this paper is to describe conventional surgical approaches to different conditions of ED used in a consecutive number of clinical cases in a referral practice, the breed distribution and a preliminary follow-up.

Materials and methods

Clinical files of growing dogs referred for persistent grade 2 front leg lameness from January 2000 to December 2001 that underwent conventional surgical treatment for ED were retrospectively evaluated.

Diagnosis

Diagnostic data consisted of physical examination with joint palpation and manipulation to measure the elbow range of motion, of a radiographic study with two medio-lateral views, flexed and extended, and two cranio-caudal views, sagittal and 15° oblique in pronation. Radiographs were evaluated to identify the underlying condition, FCP, UAP and OCD and to measure joint incongruity, if present. FCP was diagnosed upon the following findings: ulnar subtroclear sclerosis, abnormal shape of the medial coronoid process, joint incongruity with increased space between radial head and humeral condyle and lateral coronoid process, osteophytes. OCD was evidenced in the cranio-caudal radiographic view as a defect in the profile of humeral medial condyle: UAP was diagnosed in the medio-lateral flexed view by the evidence of a radio-lucent gap between the anconeal process and proximal ulna; the degree of radio-lucency of the gap, the shape of the anconeal process, the width of the gap and the position of the anconeal process in the extended and in the flexed view, were evaluated to anticipate firm or loose attachment of the anconeal process.

FCP surgical treatment

The dog, with routine general inhalant anaesthesia, was positioned on the surgical table in dorsal recumbency, with a sand bag under the affected arm and the full limb was prepared for surgery. The surgeon was sitting close to the surgical table and wore a front halogen lamp to have a better vision of the inside of the joint.

A 1 cm skin incision was performed starting 1 cm distally from the eminence of medial condyle, over the flexor carpi radialis muscle and parallel to it. After incision of the fascia brachialis, with blunt dissection between the cranial fibres of the flexor carpi radialis muscle the joint capsule was reached and incised. A small Gelpi retractor was inserted beneath the collateral ligament cranially and the joint capsule caudally, taking care not to tear the ligament. With gentle foot supination and elbow abduction the joint space was opened enough to allow inspection of the medial coronoid process, of the medial humeral condyle and of the medial side of the radial head. In FCP cases, with the aid of dental curettes and small periosteal elevators the fragmented medial coronoid process was removed and any protruding part of the remained process was worn off. Any step between the coronoid process and the humeral head was evaluated and measured using as a reference a 2 mm blunt Kirschner wire. After copious joint irrigation with saline solution, the joint capsule was closed with absorbable suture; after the suture of the fascia 1 to 2 ml of 0.25% bupivicaine was injected into the joint as a pain treatment for immediate post-op. Subcutaneous and skin suture completed the surgical procedure.

OCD surgical treatment
In OCD cases, with the same approach described for FCP, the cartilagineous flap was removed from the humeral condyle, as well any loose fragment on the periphery of the lesion; small holes in the subchondral bone were performed with the angled dental curette to promote fibrocartilagineous tissue formation unless it was already esthablished. Copious saline irrigation and surgical wound closure was performed as for FCP treatment.

Distal ulna dynamic osteotomy
When joint incongruity was evidenced in the radiographic study and intraoperatively to be higher than 1 mm, in dogs not older than 9 months, a distal ulna dynamic osteotomy was performed with the aim to shorten the ulna and to lift the radial head in closer contact with the humeral condyle. Osteotomy was performed subperiosteally 2 to 3 cm proximal to the distal ulna physis line, removing a bone segment 5 to 7 mm wide, through a 3 cm lateral skin incision. In immature dogs distal ulna osteotomy was easily performed with a bone rongeur, biting the bone piece by piece, without injuring the interosseous artery and vein and taking care not to involve the radius to avoid future synostosis between radius and ulna.

UAP surgical treatment
The dog, with routine general inhalant anaesthesia, was positioned on the surgical table in dorsal recumbency, and the full limb was prepared for surgery. The surgeon was sitting close to the surgical table on the side of the affected limb and wore a front halogen lamp to better visualize the inside of the joint. In all UAP cases a proximal ulna dynamic osteotomy was performed to restore joint congruity and to relieve any pressure on the fixed anconeal process during its healing. Skin incision started 2 cm proximal to the lateral humeral condyle ending caudally on the shaft of the ulna. Arthrotomy was performed with a sharp incision of the fascia and the anconeal muscle along its fibres, followed by careful inspection and palpation of the anconeal process to assess its remained connection with proximal ulna, if it was firm, moderately loose or completely loose. When the anconeal process was firm or moderately loose, it was fixed to the proximal ulna with a compression screw inserted from the caudal ulnar cortex and using an aiming device to direct the screw exactly toward the tip of the anconeal process. Usually 2.7 screws of 36 to 40 mm length were used, and in giant breeds 3.5 cortical screws of 40 to 44 mm length were used. When the mobility of the process was requiring a stronger fixation to avoid rotational forces a second screw was inserted. When the mobility of the process was complete, being connected only by the caudal ligament, the process was removed because healing was unlikely.

Proximal ulna dynamic osteotomy
The proximal ulna was approached through a caudal incision of fascia and perosteum at a level approximately 2 to 3 cm distal to the radial head, as a reference. Subperiosteal elevation around the entire ulna allowed to insert a gauze to protect interosseous vessels and soft tissues from the oscillating saw blade. The osteotomy was performed with an inclination of approximately 45° from caudal and proximal to cranial and distal. Once the osteotomy was completed, the fascia and periosteum were sutured with absorbable thread. Subcutaneous and skin closure completed the surgical procedure.

Aftercare
In every cases a soft padded protective bandage was applied for one week and dogs were allowed to walk only at a leash for one month in FCP and OCD cases and for two months in UAP cases. All dogs were given meloxicam p.o. at home for two to three weeks at 0.08 mg/kg once a day. After the rest period dogs were encouraged to exercise progressively to promote muscular mass and increase the range of motion of the affected joint.

Follow up
Dog owners were suggested to return the dog for follow-up one month and three to six months after surgery: medio-lateral flexed and extended and cranio-caudal radiographic views were performed and the degree of arthrosis was evaluated according to the IEWG method and compared to the preoperative degree. Joint congruity was evaluated and compared to the preoperative findings. Range of motion (ROM) was evaluated, measuring the maximum flexion and extension angles. Dogs were evaluated during walking, any persistent lameness was recorded and client satisfaction was investigated.

Results

177 dogs were included in the study with 214 surgically treated elbows; in 117 dogs (131 elbows) FCP was diagnosed and treated, in 23 dogs (25 elbows) OCD was diagnosed and treated and in 49 dogs (67 elbows) UAP was diagnosed and treated. Surgical treatment of FCP was performed in one elbow in 103 dogs (88.0%) and in both elbows in 14 dogs (12.0%). Surgical treatment of OCD was performed in one elbow in 21 dogs (91.3%) and in both elbows in 2 dogs (8.7%). Surgical treatment of UAP was performed in one elbow in 31 dogs (63.3%) and in both elbows in 18 dogs (36.7%). In 11 dogs FCP was associated to OCD and in 1 dog FCP was associated to UAP. The median age in FCP cases was 32 weeks, in OCD cases it was 24.5 weeks and in UAP cases it was 25 weeks. Sex distribution was evidencing higher incidence in male dogs for all conditions, mainly for UAP and FCP. In FCP cases elbow incongruity was assessed in 92 elbows (70.2%) and distal dynamic ulna osteotomy was performed.
Follow-up is still in progress for complete data collection and evaluation; the preliminary report shows that at follow-up at 3 to 6 months after surgery most dogs affected by FCP and OCD showed a moderate radiographic increase of DJD signs in spite of good to excellent limb function. Range of motion was compared before and after surgery, and it usually resulted diminished in flexion of some extent. Better results in range of motion were seen in dogs that were trained with treadmill or with swimming during the rehabilitation period. UAP cases, when the anconeal process regained bony fusion and surgical treatment was performed early, before radiographic evidence of arthrosis, no or only mild signs of arthosis were seen, and the ROM was full. At follow up at 6 months, Grade 1 lameness was observed in several dogs with unilateral disease and Grade 2 in few dogs. Client satisfaction was rewarding in most cases, in spite of persistent elbow arthrosis and occasional lameness after exercise or after prolonged rest. The first available data at longer follow up show a further reduction of lameness.

BREED	dogs	elbows	FCP		OCD		UAP	
No. dogs/elbows	177	214	117 dogs 131 elbows		23 dogs 25 elbows		49 dogs 67 elbows	
No. dogs monolat/bilateral			Monolt. 103	Bilat. 14	Monolat 21	Bilat. 2	Monolat 31	Bilat 18
German Shep.	65	83	30+1	3	0+1	0	17	15
Labrador	42	53	30	7	4+7	1	0	0
Rottweiler	20	21	18	1	0	0	1	0
Newfoundland	11	12	7	1	2+3	0	1	0
Golden	10	11	7	1	2	0	0	0
Corso	5	6	0	0	0	0	4	1
St.Bernard	4	6	1	0	0	0	1	2
Bernese	4	4	4	0	0	0	0	0
Dogue	4	5	1	0	2	1	0	0
P.Bergamasco	3	3	3	0	0	0	0	0
Neapol.Mastiff	3	4	1	1	0	0	1	0
Tchorny Terrier	2	2	0	0	0	0	2	0
Bull Mastiff	1	1	0	0	0	0	1	0
Czeck. Wolf	1	1	0	0	0	0	1	0
Italian Bracco	1	1	0	0	0	0	1	0
Bassethound	1	1	0	0	0	0	1	0

Contemporary diseases: 1German Shep. FCP/OCD, 1 German Shep. FCP/UAP, 7 Labrador FCP/OCD, 3 Newfoundland FCP/OCD

Disease	Male dogs	Female dogs
FCP	71 (60.2%)	47 (39.8%)
OCD	13 (59.1%)	9 (40.9%)
UAP	35 (71.4%)	14 (28.6%)

Disease and No elbows returned for follow-up	Follow-up at 6 months p.o.: degrees of arthosis (IEWG scoring)		
	= as before surgery	1 degree more	2 degrees more
FCP - 102 elbows	8 (7.8%)	78 (76.5%)	16 (15,7%)
OCD - 19 elbows	0	7 (36.8%)	12 (63.2%)
UAP - 65 elbows	38 (58.5%)	20 (30.8%)	7 (10.7%)

Disease and No elbows returned for follow-up	Follow-up at 6 months p.o.: degree of lameness		
	no lameness	Grade 1	Grade 2
FCP - 102 elbows	79 (77.5%)	21 (20.6%)	2 (1,9%)
OCD - 19 elbows	12 (63.2%)	6 (31.6%)	1 (5.2%)
UAP - 65 elbows	53 (81.5%)	10 (15.4%)	2 (3.1%)

Discussion

Surgical treatment of ED was shown to reduce joint degeneration and in very early cases to arrest it. According to our data the evolution of arthrosis was dependant mainly by the time of diagnosis and of treatment, with better results when diagnosis and treatment were very early, with no or very mild radiographic signs of arthrosis. With early treatment fibrocartilage repair of damaged cartilage avoids prolonged exposure of subchondral bone in joint environment which was demonstrated to trigger the activation of inflammatory mediators. Once joint degeneration was already established even surgical treatment was not able to arrest the advancing process of arthrosis. Because we did not see clinical complications following surgical mini approach to elbow joint in puppies 16 to 24 weeks old, our protocol was to perform surgical treatment as soon as possible, mainly in UAP and in OCD were the joint inflammation and degeneration is usually extensive and fast. In FCP we noticed better results when joint incongruity in puppies was treated with dynamic distal ulna osteotomy to promote spontaneous anatomical joint congruity; at that age the bone moulding adaptability of radial head allows its reshape as it comes into full contact with the humeral condyle and furthermore at that age the interosseous radio-ulnar ligament is easily stressed. This procedure was not as helpful in improving joint congruity in older puppies (32-40 weeks), closer to skeletal maturity; in older puppies the moulding capability of joint components is lost and the interosseous radio-ulnar ligament is stronger. Distal ulnar osteotomy had a very low morbidity and the weight bearing on the operated leg was encouraged the day after surgery walking on a lesh, to promote the downward sliding of the proximal ulna before callus formation which was very fast. Complete bony fusion of the distal ulnar osteotomy take place after few months.

UAP treatment was fully successful when performed very early, at 16 to 22 weeks of age, when the anconeal process was still connected by fibrocartilagineous tissue and joint inflammation was mild. Lag screw fixation in combination with proximal dynamic oblique ulna osteotomy were providing consistent results. In the few cases in which screw fixation failed to fuse the anconeal process, this was due to late surgery with advanced degeneration of the process and of its opposite surface of the ulnar troclear notch. In the latter cases, even without fusion of the anconeal process, the improved joint congruity provided by dynamic ulna osteotomy avoided the severe joint degeneration observed in UAP incongruent joints conservatively treated. We saw several cases of concomitant lesions, mainly OCD and FCP, while FCP was constantly associated to different degrees of kissing lesions. Most of the treated cases of FCP and OCD were unilateral, with the opposite elbow normal or minimally affected. Several UAP cases were bilateral and their treatment was more demanding: because of the morbidity of proximal ulna osteotomy surgery was performed in two times, 2 to 3 weeks a part; unfortunately at time of surgery the second elbow was usually in worse conditions.

Our experience with mini invasive surgical approach to elbow joint for FCP and OCD was rewarding, with a very quick recovery time that was comparable to the one we observed after the arthoscopy treatment we did in other ED cases. We never severed the medial collateral ligament to preserve full joint stability.

Postoperative care was very important in providing a good rehabilitation; in the first month p.o. walking on a leash on a regular basis, avoiding heavy plays, jumping and running was recommended. Thereafter swimming or daily exercise on the trot was shown to greatly improve muscular mass, range of motion and limb function. In several cases when dogs were kept at prolonged rest because the owner was worried that the dog was still limping, the vicious circle of muscular atrophy and weakness and rest prolonged greatly the recovery time and ROM resulted more reduced. Dogs that were still lame at 6 months p.o. showed a clear improvement when evaluated later on, due to exercise and better muscular tone.

The breeds we observed to be affected by ED are reflecting breed predisposition to different ED conditions and breed diffusion in our country; the 83.6% of our cases were involving 5 breeds, German Shepherd, Labrador Retriever, Rottweiler, Newfoundland and Golden Retriever. Interestingly several Italian breeds (Corso, Neapolitan Mastiff, San Bernard, Pastore Bergamasco and Italian Bracco) were shown to be affected by ED. As in others reports, incidence of clinical ED is higher in male dogs than in female dogs.

Conclusion

This study showed that conventional surgical treatment of ED with mini invasive approaches was a worthwhile procedure. Surgical treatment of ED provided better results in reducing degenerative joint disease when performed very early. Treatment of different conditions underlying ED included treatment with dynamic ulna osteotomies of any joint incongruity evidenced by the radiographic study and by arthrotomy. Usually, even early surgical treatment of ED did not completely avoid some development of arthrosis.

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