Summative review of breed standard associated disorders and hereditary diseases in the Dutch Chow-Chow dog

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Abstract: We have reviewed the world scientific literature for diseases reported in Chow-Chows. This resulted in a long list of diseases which are discussed in this report. The organ systems in which diseases were reported in this breed were musculoskeletal system, central nervous system, skin, and eyes. We have consulted internationally recognized and experienced specialists in these specialisations (Orthopedics, Neurology, Dermatology, Ophthalmology) working in the University Clinic for Companion Animals of Utrecht University. These experts have reviewed their case load which represents the diseases important for the Dutch population. The expert opinions, together with the information available from the breed club, has resulted in a short A-list of important genetic diseases in Dt]utch Chow-Chows. The A-list consists of Cranial cruciate ligament rupture, Patellar luxation, and Entropion. Diseases which are mentioned in the international literature but certainly not very important for the Dutch population have been mentioned in the B-list; the C-list contains diseases which are mentioned in the literature but for which there is no evidence of any importance or Dutch dogs or even at all. Presently it is only useful to concentrate on diseases in the A-list. Whether B-list diseases are important, will become obvious in the coming years when the new national veterinary database for incidence of diseases in dog breeds in the Netherlands become available.

Samenvatting: In dit onderzoek is de wetenschappelijke wereldliteratuur (voornamelijk afkomstig uit de USA) onderzocht op het voorkomen van ziekten die mogelijk een erfelijke basis hebben in de Chow-Chow. Dit resulteerde in een long list van ziekten waarvan de details in dit verslag zijn besproken. Deze lijst is voorgelegd aan internationaal erkende specialisten werkzaam bij de Universiteitskliniek voor Gezelschapsdieren (UKG), en fulltime actief op het gebied van ziekten genoemd bij hun specialisatie en orgaansysteem. De betreffende specialismen waren de Orthopedie, de Neurologie, de Dermatologie en de Oogheelkunde. Deze specialisten hebben op basis van hun klinische ervaring en patiëntregistratie nagegaan welke ziekten van de long list daadwerkelijk opvallend vaak bij Chow-Chows in Nederland worden vastgesteld. Met meeweging van de informatie die de rasvereniging beschikbaar heeft gesteld, resulteerde dit in een korte A-lijst van erfelijke ziekten waarvan met zekerheid kan worden vastgesteld dat ze regelmatig in Nederland voorkomen. Het betreft voorste kruisband lesie/ruptuur, patellaluxatie, en entropion. Voorste kruisband lesie/ruptuur komt op oudere leeftijd voor. Patellaluxatie is al op jonge leeftijd zichtbaar. Beide knieaandoeningen hebben waarschijnlijk verband met een steile stand van het kniegewricht. De derde ziekte is entropion, een naar binnen krullend ooglid dat op het hoornvlies drukt en oogontsteking veroorzaakt. Ziekten die in Nederland weinig of niet voorkomen maar wel veelvuldig internationaal worden genoemd, staan op de B-lijst. Of deze ziekten op den duur toch enig belang hebben wordt de komende jaren duidelijk uit het door het Expertisecentrum Genetica Gezelschapsdieren van de UKG ontwikkelde internet gebaseerde meetsysteem. Hiermee worden

online diagnoses uit alle Nederlandse dierenartspraktijken voor gezelschapsdieren verzameld en geanalyseerd, resulterend in incidentie van ziekten in alle Nederlandse hondenrassen. Op de resulterende C-lijst staan ziekten die wel in de literatuur zijn genoemd maar niet van belang zijn.

Key words: Chow-Chow, canine, breed standard associated disorders, inherited diseases.

Introduction

The Chow-Chow is a dog breed that has, over the past few decades, experienced a declining level of popularity in the Netherlands. The breed is known for its bear-like appearance, its stiff gate and the so-called scowl: a frown caused by the shape and placement of the eyes and ears. Another remarkable feature of the Chow-Chow is it's blue tongue; although not unique to the breed, it never ceases to amaze.

The Chow's loyal yet stubborn personality and its tendency to guard its property and owners rather aggressively make the Chow a family-dog, but certainly not for everyone: Some knowledge regarding discipline is required in order to enjoy the Chow-Chow to its full extend. However, if you do, you will enjoy a companion for life.

Just like any other breed, the Chow comes with breed standard associated disorders and inherited diseases, that need to be taken into account when selling or purchasing the dog. Although maintenance and further development of the breed occur on a global scale, this thesis will focus on those breed standard associated disorders and inherited diseases most commonly diagnosed in, and therefore most relevant to, the Dutch Chow population, and will provide readers and possible future owners with more insight into the breed's shortcomings.

Materials and methods

The breed standard associated disorders and hereditary diseases described in this thesis were selected based on information provided by the secretary of the Dutch Chow-Chow Club (NCCC) and on a literature search, whereby careful attention was paid to the potential presence of unintentional bias of the secretary of the NCCC and to the publication dates and thereby reliability and relevance, as well as to the nationality, of the articles. The following databases were used: CAB Abstracts, PubMed, SCOPUS, Merck Veterinary Manual, and WorldCat.

The disorders and diseases were then subdivided into four categories – orthopaedics, dermatology, neurology, and ophthalmology – and organ specialists working at the Utrecht University Clinic for Companion Animals (Universiteitskliniek Utrecht, UKG), all being internationally recognized diplomats of the respective European Colleges of Specialization, were asked to give their professional opinion as to whether or not the disorders and diseases were significantly more commonly diagnosed in the Chow than in other breeds. An important source with background information was the report: "Gezondheidsinventarisatie bij de Chow Chow in Nederland: Steekproef jaargangen 2003-2007, enquêtering 2010", verslag 2011 door Genetic Councelling Services (35).

Taking the Chow's Chinese, German, English, American, and Eastern European influences into account, the disorders and diseases were then subdivided into three categories,

category A, B, and C, based on the following criteria:

1. The extent to which the disorder or disease is documented in up-to-date literature, the nationality of the articles, and the extent to which the literature refers to the Chow in particular
2. The expert's opinion, based on clinical experience with the Chow breed. The experts are the internationally recognised specialists registered by European Colleges of Specialization, and working as expert for the relevant organ system at the UKG
3. Relevance of the disorder or disease according to the NCCC, also based on (35)

A table providing an overview of the categorization was then constructed based on these data.

In this thesis, each organ system will be reviewed individually and will thereby be subdivided into four parts: First, the literature review will be presented, introducing the different breed standard associated disorders and diseases described, determining their relevance according to literature findings, and providing brief information concerning the individual disorders and diseases. Second, the opinions obtained from the organ specific experts at the Utrecht University Clinic for Companion Animals will be presented, and third, the NCCC data will be included. Finally, a conclusion will be drawn concerning the relevance of each individual breed standard associated disorder or inherited disease, thereby placing each disorder/disease in either category A, B, or C.

Results

1 Orthopaedics

Literature review

The orthopaedic disorders described in this thesis include the cranial cruciate ligament rupture, patellar luxation, elbow dysplasia, hip dysplasia, and spondylosis deformans.

Many studies, including American, English, and Eastern European studies, have been performed with the aim of determining the incidence, etiology and pathogenesis of both the cranial cruciate ligament rupture and patellar luxation. The Chow breed is thereby frequently mentioned as a predisposed breed. In contrast, up to date literature reports that neither elbow nor hip dysplasia occurs more often in the Chow than in other breeds, and there have been no reports that spondylosis deformans is particularly common in the Chow breed either.

1.1 Cranial cruciate ligament rupture

1.1.1 Incidence

The Cranial Cruciate Ligament rupture is the most common orthopaedic disease in dogs, with concurrent meniscal damage in as many as 60% of all cases (1).

A retrospective study was performed from 1999 to 2005 to characterize the risk factors for the cranial cruciate ligament rupture, which turned out to be breed, age, sex and, bodyweight. Results also showed that the Chow was one of the breeds most likely to develop the cranial cruciate ligament rupture, with an incidence of 36%, and that, at age 5,58, the prevalence was highest. Also, females (59,14%) turned out to be more prone to the condition than males (40,86%), and neutering the animal influences the prevalence as well, since sexually intact animals (76,15%) were more represented than neutered dogs (17,76%). The database of the risk factors for the dogs bearing cranial cruciate ligament rupture examined in this

study was similar to what is seen in foreign literature (2).

In another study, histological examination results showed that degenerative changes of the ligament, decreasing the resistance to forces of pull, are more severe with advancing age and occur earlier in dogs of larger breeds, with a body weight exceeding 15kg (3).

1.1.2 Etiology and pathogenesis

The etiology of the cranial cruciate ligament rupture remains largely unclear. The integrity of the cranial cruciate ligament may be lost due to direct trauma of the stifle, possible also resulting in damage of other structures (3), but the most frequent cause of the disorder is excessive trauma combined with a weakened ligament secondary to degeneration, immune-mediated diseases or conformational defects, such as straight-leggedness (4). Considering that straight-leggedness is a characteristic seen in the Chow breed, it is very likely that the breed's predisposition to the cranial cruciate ligament can be partially explained by this conformational defect. However, there is no proven evidence that straight legs are an important causative factor; opposite opinions have been mentioned although not in formal scientific literature (36).

1.1.3 Clinical symptoms

In most cases the cranial cruciate ligament rupture involves a mid-substance tear, although with the immature dog, bone avulsion at the origin of the ligament is also possible (4).

Clinical symptoms include lameness, pain, crepitation, medial joint swelling, effusion, excessive cranial laxity of the proximal tibia relative to the distal femur, and increased internal tibial rotation. A partial rupture is characterized by a reduced cranial laxity, which is usually more pronounced in flexion of the stifle joint. Sometimes, a plasmacytic-lymphocytic synovitis is seen concurrently with ligament injury but whether the synovitis is the cause or result of the cranial cruciate ligament rupture remains unclear (4).

The instable joint that results from rupture of the cranial cruciate ligament can lead to medial meniscal injury, osteophyte formation, joint effusion, and joint capsule fibrosis (4). In addition, studies on Chows have shown that the knee flexion angle combined with the irritation of the knee joint capsule resulting from the cranial cruciate ligament rupture significantly accelerates the onset of osteoarthritis (5).

1.1.4 Diagnosis

The cranial cruciate ligament rupture will give a positive compression test or drawer sign. As already stated, the partial rupture is characterized by a reduced cranial laxity. Laxity of the cranial cruciate ligament can be demonstrated by a tibial compression test, whereby the hock is flexed and the tibial tuberosity is displaced cranially. Medial injury to the meniscus will give a clicking sound during locomotion, both in flexion and extension (4).

Radiographs will show joint effusion and, in chronic injuries, signs of degenerative joint disease. Arthrocentesis, in addition, may reveal a mild increase in the cellular component of the synovia, and haemarthros may be diagnosed. To confirm the diagnosis, arthroscopy may be applied (4).

Recently, a study showed that the PLA (patellar ligament angle) of stifles with a complete CCL rupture was significantly lower than that of normal stifles, particularly at a flexion angle of 60 to 80 degrees. Also, if the PLA was <90.55 degrees with a 60 to 80 degrees flexion angle, the dog was diagnosed

with a complete CCL rupture with a sensitivity of 83,9% and a specificity of 100%. In other words, measuring the PLA is a quantitative method for diagnosing a complete CCL in canines (6).

1.1.5 Therapy

To reduce pain and discomfort from the inflammation and degeneration of the joint, weight reduction, controlled physiotherapy, and NSAID's are indicated (4).

The early, mild condition as seen with stable (nonsurgical) joints can be treated with steroidal or non-steroidal drugs (NSAID's). For active dogs, however, surgical stabilization of the stifle joint is recommended, combined with postoperative physical therapy, the latter being critical for clinical recovery (4).

There is a variety of surgical techniques available to treat the cranial cruciate ligament rupture, including both extra-capsular, intra-capsular, and osteotomy methods. Some of the techniques currently used include the Tight Rope (TR), the Lateral Suture (LS), tibial tuberosity advancement (TTA), and Tibial Plateau Levelling Osteotomy (TPLO).

1.1.6 Prognosis

The prognosis after surgery is good (4). Research has shown that, approximately two and a half years after surgery (surgical treatment entailing intra-capsular, extra-capsular, and/or osteotomy techniques), the dynamic and static weight bearing of the surgically treated limb returns to the level of healthy limbs. However, extension and flexion angles of the surgically treated stifles remain inferior to healthy joints, and the active range of motion (AROM) and weakness in thrust from the ground are frequently present in surgically treated limbs (7).

In up to 50% of all dogs treated surgically for Cranial Cruciate Ligament ruptures, subsequent meniscal tears occur. It is however important to realize that the type of CCL surgery performed does not affect, positively neither negatively, subsequent meniscal tear rate or mid-term or long-term functional outcomes. Meniscal release is associated with a significant reduction in the incidence of subsequent tears, without clinically impairing functional outcomes, but meniscal release does not eliminate subsequent meniscal tears altogether. Diagnosing and treating meniscal pathology is imperative for optimizing post-surgical outcomes in dogs treated for Cranial Cruciate Ligament disease, and fulminant meniscal pathology is to be treated by partial meniscectomy and/or meniscal release (1).

Meniscal damage that goes undiagnosed at the time of the initial cranial cruciate ligament surgery can cause persistent lameness and will require additional surgery (1).

1.2 Elbow dysplasia

1.2.1 Incidence

The prevalence of elbow dysplasia ranges from 0 to 64% within the different breeds and heritability ranges from 0,1 to 0,77 (8). In the Dutch breed stock of Chow Chows a limited number of dogs has been examined radiographically. In this survey it was shown that a considerable fraction of the dogs had LPC (fragmented coronoid process), often associated with secondary arthrosis.

1.2.2 Etiology and pathogenesis

Elbow dysplasia appears to be inherited differently in different breeds. The genetic basis of elbow dysplasia, however, has been scientifically proven through several large epidemiological studies. The differences in inheritance suggest that elbow dysplasia is a common end point for a variety of genetic

disorders that disturb elbow development through various mechanisms (9).

Elbow dysplasia is a generalized incongruency of the elbow joint that occurs in young, large, rapidly growing dogs and is related to abnormal bone growth, joint stresses or cartilage development. The condition appears to be inherited differently among different breeds (10) and includes one or more of the following joint lesions: the ununited anconeal process of the ulna (UAP), the fragmented medial coronoid process (FMCP), osteochondrosis of the medial aspect of the humeral condyle (OC), articular cartilage injury, and incongruity of the elbow joint (10,11). All of these lesions are associated with various degrees of joint instability, inflammatory processes, and loose fragments within the joint, ultimately resulting in lameness and osteoarthrosis (OA) (10). It is suspected that UAP, FMCP, and OC occur as a result of genetic predisposition, combined with secondary environmental influencing factors, such as high energy diet, together leading to rapid growth and excessive exercise (9). In European kennel clubs, radiographic grading of dysplastic elbow joints is performed (11).

1.2.2.1 Ununited Anconeal Process

Disunion of the anconeal process is the result of the separation of the ossification centre of the anconeal process from the proximal ulnar metaphysis. It has been postulated that the fracture results from biomechanical imbalance in the rapidly growing and developing elbow. After disunion of the anconeal process, a bridge of fibrous tissue forms between the anconeal process and the ulna, which fragments to form pseudoarthrosis, resulting in instability of the elbow joint. This laxity continues to damage the articular cartilage, resulting in secondary osteoarthritis. A hereditary basis has been assumed but has yet to be proven (11).

1.2.2.2 Fragmentation of the Medial Coronoid Process

This is a condition whereby the medial coronoid process fails to unite with the ulnar diaphysis, either partially or totally, and therefore fails to become part of the articular surface of the trochlear notch. This results in joint laxity, irritation, and, in a more chronic stadium, osteoarthritis. Fragmentation of the medial coronoid process, along with osteochondrosis of the medial humeral condyle, is considered to be the most common cause of osteoarthritis of the canine elbow (11).

Osteochondrosis of the Medial Humeral Condyle

Osteochondrosis of the medial humeral condyle is the result of the disturbance of endochondral fusion of the epiphysis of the medial epicondyle with the distal end of the humerus. The exact cause, however, remains unknown (11).

1.2.3 Clinical symptoms

Most dogs start showing clinical signs of elbow dysplasia around the age of 6 to 12 months, when they develop persistent forelimb lameness. Some dogs, however, present themselves later in life (<6 years old), with clinical manifestations of medial coronoid disease and little or no prior history of lameness. Another group presents itself with lameness due to continuing or progressing joint pathology (9).

An ununited anconeal process will manifest itself clinically between 4 and 8 months of age, when the dog starts to show lameness. Some bilateral cases, however, may not be diagnosed until the age of >1 year old. The

range of motion (ROM) is restricted and the affected elbow may deviate laterally. Advanced cases develop osteoarthritis, joint effusion and joint crepitations (11).

Osteochondrosis of the medial humeral condyle results in pain on flexion of the elbow or deep digital palpation and in soft-tissue swelling (11).

1.2.4 Diagnosis

Clinical signs are suggestive and the diagnosis is confirmed by radiographic imaging (11). It is to be noted that radiographic imaging is not only used for diagnosing an animal with ED, but also for grading and registry of the condition. Under normal circumstances, dogs are to be radiologically evaluated at 12 months of age. Classification of ED cases according to the International Elbow Working Group (IEWG) protocol is based on the presence and severity of arthritic changes on the joint surfaces, as well as the presence of one or more of the following: UAP, OC, FMCP, and joint malformation or incongruity (10).

1.2.4.1 Ununited Anconeal Process

An ununited anconeal process can be visualised using lateral radiography of the elbow in the flexed position. Because the condition can occur bilaterally, both elbows are to be examined (11).

1.2.4.2 Fragmentation of the Medial Coronoid Process

To diagnose fragmentation of the medial coronoid process, radiography, arthroscopy and CT can be utilized to show loose bone fragments (11).

1.2.4.3 Osteochondrosis of the medial Humeral Condyle

Osteochondrosis of the medial humeral condyle is diagnosed using radiography. Radiodence structures caudal and distal to the area of the medial epicondyle are present (11).

Because of the complexity of inheritance and the effects of environmental variables in the expression of elbow dysplasia, genetic testing is unavailable and will very unlikely become possible in de nearby future (9).

1.2.5 Therapy

Treatment should ideally involve the correction of the underlying causes before degenerative joint diseases develop. During the early stages of ED, different non-surgical therapeutic measures are available, such as analgesic therapy (NSAIDs), weight loss, exercise restriction, functional food consumption, nutritional supplements, physiotherapy, and other complementary modalities. For managing established, more developed cases of ED and for the accompanying symptoms, numerous surgical procedures have been developed, such as the retrieval of loose fragments, the resection of damaged subchondral bone and the debridement or replacement of damaged cartilage (10). Ideally, surgical procedures are performed through arthroscopy, since this surgical technique causes less damage to the animal than an arthrotomy and shortens recovery time (9).

A recent study has shown that the administration of chondroprotective formulations such as hyaluronic acid, enzymatically hydrolysed collagen, glucosamine, chondroitin sulphate, and gamma oryzanol (Hyaloral) to animals diagnosed with ED significantly reduces clinical signs and symptoms. Little is still known about prevention (10).

1.2.5.1 Ununited Anconeal Process

There are three therapeutic options available to treat the ununited anconeal process. The first includes removal of the ununited process through a lateral arthrotomy, the second includes relief of the asynchronous growth through a mid-shaft ulnar osteotomy, which hopefully results in union of the process, and the third entails reattachment of the anconeal process to the ulna by screw fixation (11).

Symptomatic therapy consists of the administration of aspirin or NSAIDs. This reduces the pain and the inflammation. Joint-fluid modifiers such as glycosaminoglycans and hyaluronic acid may be useful as well (9).

1.2.5.2 Fragmentation of the Medial Coronoid Process

Treatment of the fragmented medial coronoid process consists of a medial arthrotomy or arthroscopy, whereby the fragmented process is removed (11).

1.2.5.3 Osteochondrosis of the Medial Humeral Condyle

The key to treating osteochondrosis of the medial humeral condyle is stimulation of fibrocartilage formation. To achieve this, the subchondral bone lesion is curetted (11).

The complexity of the etiology and pathogenesis of elbow dysplasia make identification of the early stages of the syndrome difficult. Late diagnosis leads to inconsistent clinical outcomes, such as joint pathology processes. As a result, many procedures have been developed that manage the end-stage disease, including the sliding humeral osteotomy, proximal abducting ulna osteotomy, joint resurfacing, joint replacement, joint denervation and arthrodesis. A decision-making algorithm is shown in figure 1 (9).

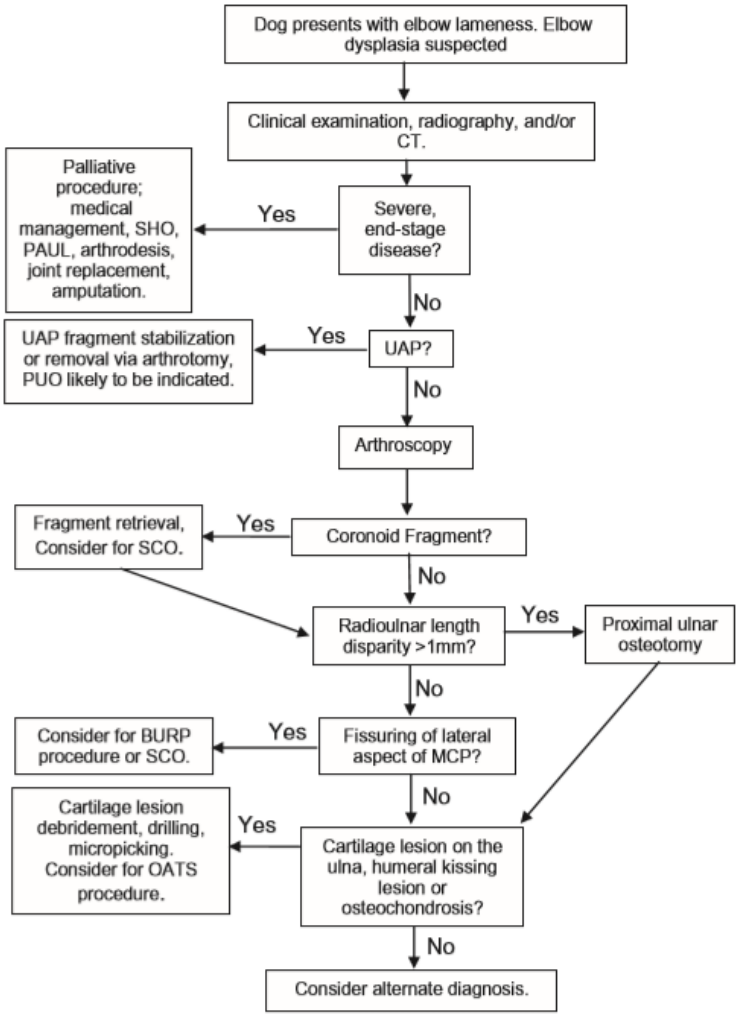


Figure 1: Algorithm for the treatment of elbow dysplasia. MCP, medial coronoid process; OATS, osteoarticular transfer system; PAUL, proximal abducting ulnar osteotomy; SCO, subtotal coronoidectomy; SHO, sliding humeral osteotomy; UAP, ununited anconeal process (9).

1.2.6 Prognosis

Provided that degenerative joint disease has not yet developed in the joint, the prognosis after surgery is good (11).

1.3 Hip dysplasia

1.3.1 Incidence

The prevalence of hip dysplasia ranges from 0 to 74% within the different breeds and heritability reportedly ranges from 0,1 to 0,6. Heritability indicates which part of the

interbreed differences observed is due to genetics (8).

To reduce prevalence, the Netherlands has implemented screening programs for not only hip dysplasia, but for elbow dysplasia as well. For several breeds, including the Chow, HD scoring is mandatory, although the maximum score allowed depends on the prevalence of HD and the size of the HD-free breeding population and is therefore different for each breeders' club. With the NCCC, the maximum score is HD-C, which means that the animal is found to be slightly positive. HD-D and HD-E exclude an animal from breeding programs. In a recent survey of HD scores of Chow Chows hip dysplasia proved to be relatively rae in this breed, certainly less frequent than ED. Screening for ED is not as common as screening for HD and is restricted to a few breeds. The Chow is, however, again included, at least with the NCCC (8).

1.3.2 Etiology and pathogenesis

Hip dysplasia is the result of a multifactorial abnormal development of the coxofemoral joint, and is especially seen in the larger dog breeds, since these breeds have a relatively high rate of longitudinal bone growth (8,12). The occurrence of hip dysplasia is affected by excessive growth, exercise, nutrition, and hereditary factors. Its pathophysiologic basis is a disparity between hip joint muscle mass and rapid bone development, resulting in coxofemoral joint laxity or instability and subsequent degenerative joint changes such as acetabular bone sclerosis, osteophytosis (new bone formation), thickened femoral neck, joint capsule fibrosis and subluxation or luxation of the femoral head (12).

1.3.3 Clinical symptoms

Clinical symptoms may start to show during or just after the fast growth period (8). It is important to realize that clinical signs do not always correlate with radiographic abnormalities and that they are very variable. Lameness, for instance, may be mild or moderate but may also be severe, and is pronounced after exercise. Sometimes, a 'bunny-hopping' gait is evident. Joint laxity (Ortolani sign), a reduced range of motion, crepitation and pain during full extension and flexion may be present (12).

1.3.4 Diagnosis

Hip dysplasia is diagnosed by closely examining the locomotor apparatus (see 'clinical symptoms') of the animal and by radiographic imaging (12).

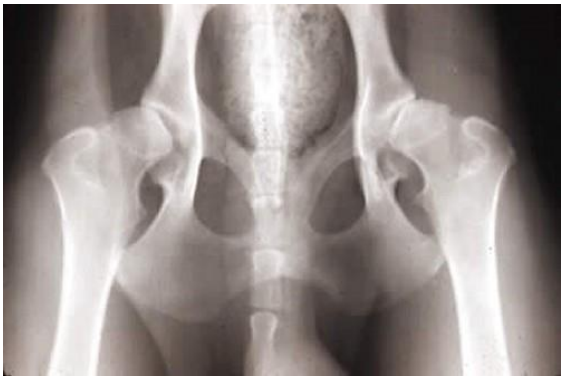


Figure 2: Radiographic image of a German Shepherd suffering from hip dysplasia (12).

Radiographic imaging is useful in determining the degree of arthritis and in planning the necessary treatments (12).

1.3.5 Therapy

Therapy can be either medical or surgical, or both. In mild, nonsurgical cases, weight reduction, restriction of exercise on hard surfaces, controlled physical therapy to strengthen and maintain muscle tone, anti-inflammatory drugs (such as corticosteroids and NSAIDs), and possibly joint fluid modifiers will do the trick. In more severe cases, where surgery is required, the treatment will include

one or more of the following procedures: pectineal myotenectomy to reduce the amount of pain, triple (or in young animals double) pelvic osteotomy to prevent subluxation, pubic fusion to prevent subluxation, joint capsule denervation to reduce pain, dorsal acetabulum reinforcement to reduce subluxation, femoral head and neck resection to reduce arthritis, total hip replacement for optimal restoration of joint and limb functions, and/or femoral corrective osteotomy to reduce femoral head subluxation (12).

1.3.6 Prognosis

Hip dysplasia, as well as elbow dysplasia, can cause lifelong disability (8). The prognosis is highly dependent on the type of treatment and its efficacy and on the overall health and environment of the animal, and is thus highly variable (12).

1.4 Patellar luxation

1.4.1 Etiology and pathogenesis

Patellar luxation is a hereditary disorder seen in animals of all ages. The disorder is characterized by the ectopic development of the patella medial or lateral to the trochlear groove of the femur. Patellar luxation can be associated with multiple deformities of the hindlimb involving the hip joint, femur, and tibia, such as a reduced coxofemoral angle (coxa vara), lateral bowing of the femur, internal rotation of the tibia, a shallow trochlear groove, and hypoplasia of the medial femoral condyle (13).

1.4.2 Clinical symptoms

Animals suffering from patellar luxation show variable clinical signs, depending on the severity of the luxation. In general, small dog breeds show a medial luxation, whereas large dog breeds usually suffer from a lateral luxation. In Chows, the lateral luxation is most common, although occasionally, the medial luxation is found as well. Animals with patellar luxation are lame or ambulant with a skipping gate (13).

1.4.3 Diagnosis

An important step in diagnosing an animal with patellar luxation is palpation of the stifle joint, since it is only possible to displace the patella in animals actually suffering from patellar luxation. The next step in diagnosing the animal is to determine the severity of the luxation. To do this, four grades have been determined: in Grade I, the patella occasionally luxates and easily returns to the trochlear groove by itself. Clinical signs are mild and infrequent. In Grade II, the patella luxates during flexion of the stifle joint and is repositioned during extension, manifesting itself clinically as a resolvable skipping lameness. In Grade III, the patella is more frequently dislocated than it is located in the trochlear groove, resulting in consistent lameness of the animal and in bone deformities. In Grade IV, the patella is constantly dislocated, and lameness and limb deformation are the most severe. Whereas in Grades I, II and III, manual reposition is possible, this is not the case anymore with a Grade IV patellar luxation (13).

1.4.4 Therapy

Therapy is always surgical, with the type of surgery based on the severity of the luxation. Surgery can include both orthopaedic and soft-tissue procedures. Some of the most useful procedures include fascial releasing incisions (on the side of the luxation), joint capsule and retinaculum imbrications (on the side opposing the luxation), deepening of the trochlear groove, tibial crest transposition, and fabella to tibial tuberosity derotation sutures. Severe deformations, as seen with Grade IV patellar luxations, may require

femoral or tibial osteotomies, stifle joint arthrodesis, or amputation of the affected limb (13).

1.4.5 Prognosis

In mildly or moderately affected animals, the prognosis for recovery is good. In animals with a Grade IV luxation, however, the prognosis highly depends on the effect of the surgery and is questionable. In some cases of patellar luxation, cranial cruciate ligament and medial meniscal injuries can be identified and should be treated as well, influencing the prognosis (13).

1.5 Spondylosis deformans

1.5.1 Incidence

The incidence of spondylosis deformans increases with age, being uncommon in dogs <2 years old, and affecting 25 to 70% of all dogs 9 years of age (14).

1.5.2 Etiology and pathogenesis

A breakdown of the outer fibres of the annulus fibrosus and therefore stretching of the longitudinal ligament increases stress at the vertebral attachment of the longitudinal ligament, inciting bony production and causing spondylosis deformans (14).

The condition is non-inflammatory and, as previously stated, is characterized by the formation of bony projections, so-called enthesophytes, at the location where the annulus fibrosus is attached to the cortical surface of adjacent vertebrae. These enthesophytes vary in size from small spurs located several millimetres from the junction between the disc and vertebra to bony bridges that span the disc space, thereby leaving at least part of the ventral surface of the vertebra unaffected (14).

In the boxer, a genetic predisposition has been identified (14).

1.5.3 Clinical symptoms, diagnosis, and therapy

Spondylosis is typically not correlated with the presence of clinical signs, since the enthesophytes typically expand ventrally and laterally and therefore rarely affect the spinal cord. In rare cases, spinal hyperesthesia is caused, which is to be treated with analgesics. Spondylosis deformans can be diagnosed using radiographic imaging (figure 3) (14).

1.5.4 Prognosis

Since the condition is typically not correlated with the presence of clinical signs, the overall prognosis is good. Depending on the location of the spondylosis, however, the animal can experience trouble standing up, jumping, etcetera, negatively influencing the prognosis.

Expert opinions

According to orthopaedic specialists at the Utrecht University Clinic for Companion Animals, the cranial cruciate ligament rupture and patellar luxation are the most commonly diagnosed and therefore most relevant orthopaedic disorders in the Dutch Chow. The same experts also state that neither elbow nor hip dysplasia is diagnosed often enough in the

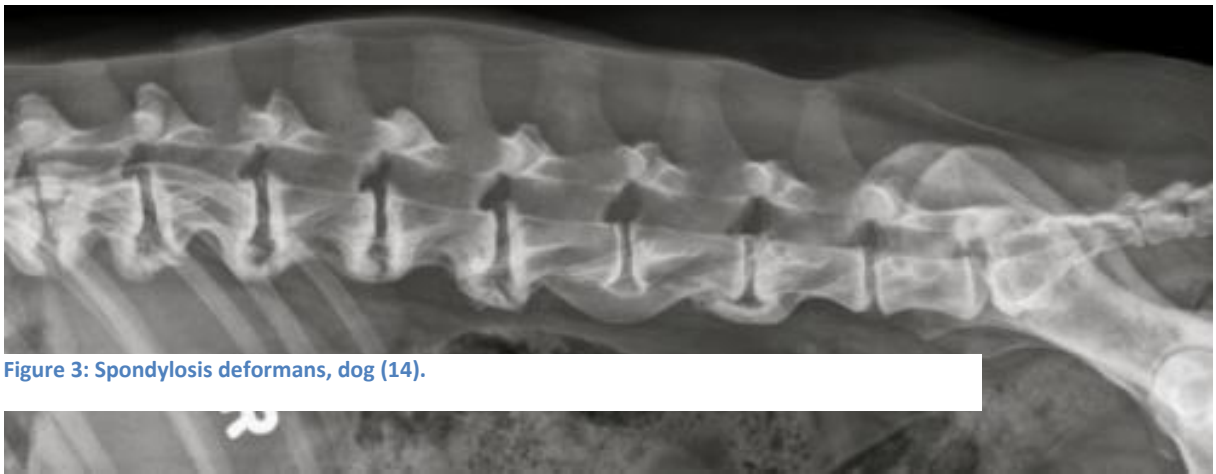


Figure 3: Spondylosis deformans, dog (14).

Dutch Chow to be Chow-specific or even relevant. As for spondylosis deformans, the orthopaedic experts go against up to date literature by stating that this disorder is notably more common in the Chow breed than in the average Dutch dog, predisposed breeds like the Boxer excluded.

NCCC data

The NCCC considers the cranial cruciate ligament rupture and patellar luxation to be two of the most important Chow breed disorders in general. Their breeding-regimen even obliges pre-breeding screening for both conditions, emphasizing their importance. The NCCC breeding-regiment also requires mandatory pre-breeding screening for both ED and HD, and the scores of ED examination in breed stock of NCCC indicates that ED is more common in the Chow than assumed. In contrast, HD is quite rare in this breed. The high prevalence of ED was not supported by the opinions of the orthopaedic experts, which may be explained by clinical symptoms versus results of screening in non-symptomatic dogs. The NCCC does not mention spondylosis deformans as a Chow breed-related problem and the condition is nowhere mentioned in the NCCC breeding-regiment

Conclusions

Because both up to date literature, orthopaedic experts at the Utrecht University Clinic for Companion Animals, and NCCC data indicate that the cranial cruciate ligament rupture and patellar luxation are two of the most relevant Chow breed-related disorders, both conditions will be placed in the A-category. As for spondylosis deformans, despite the fact that neither up to date literature nor NCCC data consider the disorder to be relevant to the Chow breed, expert opinions place the disorder in category B. The relatively high prevalence of ED in radiographic elbow screening should indicate that this is a category B disorder.

Despite the requirements of the NCCC breeding-regiment, hip dysplasia will be placed in the C-category, since neither orthopaedic experts nor up to date literature indicates that either one of these conditions is in any way Chow-related and therefore relevant.

2 Dermatology

Literature review

The dermatologic disorder described in this thesis is colour dilution alopecia, or CDA.

According to up to date literature, CDA is the only dermatologic disorder relevant to the Chow breed. It is, however, not unique to this breed; the condition is common in all blue and other 'colour-diluted' dogs, therefore including not only the Chow-Chow but also the Dobermann pincher, the Chihuahua, the Mastiff, and many other breeds.

2.1 Colour Dilution Alopecia

2.1.1 Etiology and pathogenesis

One of the three most studied genes associated with coat colour dilution in several dog breeds is the canine melanophilin gene (MLPH). Genetically-based defective transport of melanosomes leads to an accumulation of melanosomes around the melanocytes' nuclei as well as large clumps of pigment in the hair shaft, giving dogs suffering from coat colour dilution a pigmentation phenotype characteristic for the genetic disorder. The relatively uncommon hereditary skin disease is inherited as a Mendelian autosomal recessive trait (15).

Dogs suffering from coat colour dilution are predisposed to develop hair loss in the form of

Colour Dilution Alopecia (CDA) (16). Coat colour dilution and therefore also CDA generally affects dogs with coat colours considered 'dilute', with brighter shades of black or brown, known as blue, grey, fawn and red (17).

2.1.2 Clinical symptoms

Clinical signs usually develop between 6 months and 2 to 3 years of age (18). Initially, dogs suffering from CDA experience a gradual onset of a dry, dull and poor hair coat quality, particularly on the trunk. Hair shafts and hair regrowth are poor and follicular papules may develop. When hair follicle morphogenesis is aborted, these papules may progress into comedomes (16,19). The rate at which hair loss occurs varies but most light-coloured dogs are almost completely alopecic by 2 to 3 years of age (18).

Other typical consequences associated with CDA are hyperpigmentation, scaling and predisposition to solar dermatosis (19). Dogs suffering from CDA are prone to follicular plugging and secondary recurrent bacterial folliculitis which can stimulate hair loss even further and cause pruritus (18).

2.1.3 Diagnosis

Diagnosis is based on anamnesis (breed, coat colour) and symptoms, microscopic evaluation of plucked hair shafts and histologic patterns (17). A trichogram shows hairs with structural abnormalities such as large melanin clumps along the hair shaft causing distortion and fracture of the hair. Histopathologically, the epidermis is relatively normal but may be hyperplastic, and in epidermal and follicular basal cells and hair bulbs, melanin clumping occurs. Also, numerous melanin aggregates can be found in hair shafts, hair follicles occur in various stages of growth with follicular hyperkeratosis, hair shafts are fractured, the follicular lumen contains free clumps of melanin, numerous peribulbar melanophages are present, and hair follicles are characterized by atrophy and distortion. With time, all follicular activity ceases and the follicles become dilated and cystic (18).

2.1.4 Therapy

When secondary pruritus develops, oral antibiotics and gentle topical antibacterial treatment might be required. Therapy with oral retinoids and fatty acids has anecdotally been beneficial in some patients in decreasing scaling and frequency and severity of bacterial folliculitis. Also, in a case of CDA in 2005, the efficacy of melatonin was reported (18). However, in subsequent years, cases were reported where melatonin treatment was unsuccessful (20).

2.1.5 Prognosis

The prognosis for CDA on its own is poor, considering that the condition will never completely resolve itself and no therapy is available. Most complications associated with CDA are, however, curable, and therefore have a good prognosis.

Expert opinions

Dermatologic experts at the Utrecht University Clinic for Companion Animals indicate that skin problems other than hot spots, which are mostly due to poor grooming and are therefore not inherited, are not frequent in the Chow at all, with only a few dermatologic cases – with varying diagnoses – being reported annually. The experts do mention CDA as one of the dermatologic conditions sometimes seen in the Chow breed, but they – like up to date literature – emphasize that this condition is not unique to the Chow and does not occur more often in

this breed than it does in other blue or colour-diluted breeds.

NCCC data

The NCCC considers skin problems in general to be relevant in the Chow breed but does not mention CDA in particular.

Conclusions

Because both up to date literature and dermatologic experts indicate that CDA is relevant but not unique to the Chow breed and because the NCCC claims that skin problems in general are relevant to the breed but does not mention CDA in particular to be one of them, colour dilution alopecia will be placed in category B.

3 Neurology

Literature review

The neurologic disorders described in this thesis include cerebellar hypoplasia and demyelinating disorders, the latter including dysmyelination and hypomyelination. According to American literature, the Chow-Chow is one of the dog breeds that are prone to these neurologic disorders.

3.1 Cerebellar hypoplasia

3.1.1 Etiology and pathogenesis

Cerebellar hypoplasia is a non-progressive condition whereby the cerebellar vermis (a narrow, worm-shaped structure in between both sides of the cerebellum) may be partially or completely absent. When the cerebellar hypoplasia is combined with hydrocephalus and cyst-like dilatation of the fourth ventricle, this condition is called the Dandy-Walker syndrome, which may be congenital as well. The etiology of cerebellar hypoplasia as well as the Dandy-Walker syndrome remains unknown (21).

3.1.2 Clinical symptoms

A patient with cerebellar hypoplasia will show clinical symptoms typical for a cerebellar disorder, including tremors, ataxia and hypermetria. Tilting of the head and circling may occasionally be present (22).

3.1.3 Diagnosis

Animals with cerebellar hypoplasia are diagnosed with Magnetic Resonance Imaging, or MRI. Hydrocephalus and hydranencephaly may also be found (22).

3.1.4 Therapy

There is no treatment available for cerebellar hypoplasia.

3.1.5 Prognosis

Affected animals may still make suitable pets (22). However, with no treatment available, there will be neither progression nor improvement of the cerebellar abnormalities and patients will not clinically improve their neurologic status (23).

3.2 Demyelinating disorders

Demyelinating disorders can be subdivided in two conditions: hypomyelination and dysmyelination. Both conditions are characterized by a disruption of myelin development. Hypomyelination is characterized histologically by thinly myelinated axons with predominantly *normal* myelin and mainly non-myelinated axons, whereas dysmyelination, as the name suggests, is characterized by thinly myelinated axons with predominantly *abnormal* myelin and mainly non-myelinated axons (24).

3.2.1 Etiology an pathogenesis

There are two causes of demyelinating disorders: in utero infection and heredity. In

hereditary central nervous system (CNS) demyelination, the basic defect involves interference with the functional maturation of oligodendrocytes, but the exact mechanisms for the defect are unknown (24).

Since in most instances males are affected more often and more severely than females, a sex-linked recessive inheritance is suspected. The genetic basis has not yet been fully defined (24).

3.2.2 Clinical symptoms

Clinical symptoms usually develop around the age of 2 to 8 weeks, with manifestations of CNS hypomyelination having been reported as early as 10 to 12 days. The most profound signs include a gross whole body tremor that involves the limbs, trunk, head and eyes that lessens or even completely disappears when the animal is at rest or asleep but reappears on arousal and increases with excitement. The tremors are a severe form of intention tremor and are very clearly observed when the animal is eating. Some animals may experience difficulty standing and ambulating and may be weak in the limbs. Postural test reactions may therefore be deficient. Occasionally, a pendular nystagmus or a jerk nystagmus is seen (24).

3.3 Diagnosis

Diagnosis is based on the spectrum of neurologic deficits and the early age of onset. In cases with a heritable basis, pedigree evaluation may be helpful. Antemortem, MRI can be a useful tool to diagnose demyelinating disorders, but the only way to confirm the diagnosis is histopathology, in other words: postmortem examination of the animal (22,24).

3.3.1 Therapy

There is no treatment available. The only way to avoid it is to prevent the animal form developing the disorder in the first place. For heritable demyelination, this can be done through selective breeding (24).

3.3.2 Prognosis

The neurologic deficits may be so severe that euthanasia is warranted (24). However, in not only Chows but also Weimaraners and Bernese Mountain Dogs, the clinical signs of whole body tremors usually resolve spontaneously over time (22) and the animal is normal again by the age of 12 to 18 months. With some dogs, signs may even disappear as early as 12 to 16 weeks of age (24).

Expert opinions

In contrast to what American literature states, neurologic experts at the Utrecht University Clinic for Companion Animals claim that the Chow breed is not at all prone to neurologic disorders, basing their opinion on the fact that, over the past 30 years, they have hardly ever seen a Chow-Chow suffering from a neurologic disorder, with no neurologic disorder being diagnosed in particular either.

NCCC data

NCCC data coincide with expert opinions, indicating that no neurologic disorder occurs on a frequent and therefore relevant basis in the Chow breed.

Conclusions

Although American literature states that neurologic disorders are relevant to the Chow breed, the low frequency of Chows being diagnosed with neurologic disorders at the Utrecht University Clinic for Companion Animals combined with NCCC data indicating that neurologic disorders are irrelevant to the

Chow breed places both cerebellar hypoplasia and demyelinating disorders in the C-category.

4 Ophthalmology

Literature review

The ophthalmologic disorders described in this thesis include cataract, distichiasis, entropion, and glaucoma.

According to American research, cataract is one of the most common ocular disorders in the American Chow. Up to date literature however shows that the Chow in general is not particularly prone to the condition. The same can be said for distichiasis.

In contrast to cataract and distichiasis, both American research and up to date literature have shown that the Chow breed is one of the breeds most prone to both entropion and glaucoma.

4.1 Cataract

4.1.1 Etiology and pathogenesis

Cataract is a complete or partial opacity of the lens and/or of its capsule. It is more commonly found in dogs than in other animals and varies with age of onset, rate of progression, and origin of formation (25).

It is assumed that cataract is hereditary, with the exception of cases known to be associated with trauma, other causes of ocular inflammation, radiation, specific metabolic diseases (diabetes mellitus being the second most frequent group of cataract surgery in the canine), persistent pupillary membrane, persistent hyaloid, or nutritional deficiencies (25). In the Chow, however, the only reported case of cataract is congenital (26).

4.1.2 Clinical symptoms

The clinical appearance of cataract is variable, ranging from one to a few small nuclear or capsular opacities to a generalized, diffuse cataract. The nucleus of the lens is most consistently affected and the peripheral lens, the cortex, is variably involved. When cataract is complete or diffuse and affects both eyes, this results in blindness of the animal (26).

In Chows with cataract, other ocular anomalies including entropion, microphthalmia, persistent pupillary membranes, and retinal folds may be found, although a direct relationship between these conditions and the cataract remains unclear (26).

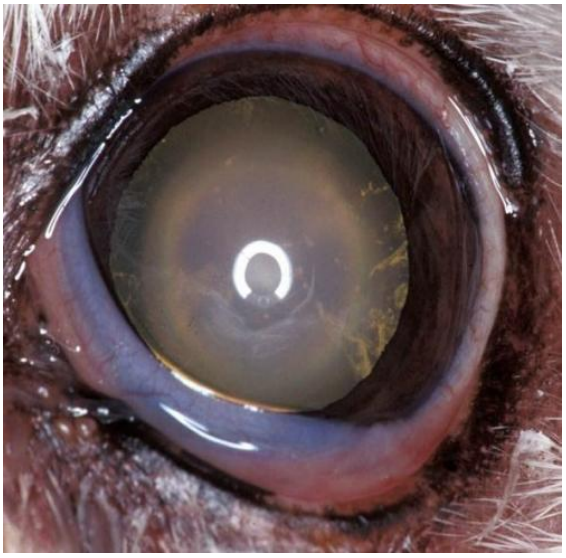


Figure 4: Nuclear sclerosis (central gray zone) and early cataract formation (small bubbles) in the peripheral lens of an aged American Cocker Spaniel (25).

4.1.3 Diagnosis

Cataracts are usually classified according to the age of onset, the anatomic location, the cause, the degree of opacification, and the shape (25).

Most cataracts can be diagnosed by dilating the pupil and examining the pupillary region against the retroillumination of the tapetal fundus. Using slit-lamp biomicroscopy, optimal direct examination of the lens can take place (25).

4.1.4 Therapy

Animals suffering from immature and incomplete cataracts may benefit from the application of topical ophthalmic atropine, since this allows vision around a central or nuclear cataract. However, the only definitive therapy for cataract includes surgical removal of the lens. Cataract extraction yields the best results when it is performed before completion of cataract maturation and leakage of lens material, the latter resulting in lens-induced uveitis (25).

In animals that do not undergo cataract surgery, continuous clinical monitoring is of high importance. The lens-induced anterior uveitis often requires long-term monitoring and repeated tonometry, and occasionally corticosteroid and mydriatic therapy (25).

4.1.5 Prognosis

When cataract surgery is applied, the intensity of lens-induced uveitis increases, thereby contributing substantially to the manifestation of postoperative complications, including glaucoma and phthisis bulbus formation. In young animals, however, the congenital nuclear cataract may reduce in size with growth of the lens, thereby permitting restoration of vision as the animal matures, and eliminating the need for surgical methods and the risk of postoperative complications (25).

4.2 Distichiasis

4.2.1 Etiology and pathogenesis

Anomalies of the cilia are common and, in the Chow, most likely inherited (27).

Distichiasis, derived from the Greek words *di* (meaning two) and *stichos* (meaning row), refers to cilia that arise in tarsal plate tissue and emerge on the lid margin from the meibomian (tarsal) gland openings, or, less frequently, from the Zeis or Moll gland openings. (28).

The main cause of trichiasis in the Chow is the excessive facial skin folding. Knowledge concerning etiology and pathology of distichiasis is, however, limited, with different theories having been proposed. The ectopic cilia may develop from metaplastic tarsal glands or from germinal epithelium (follicles) located within or adjacent to the tarsal glands, but histologic studies substantiating this theory have yet to be performed (28).

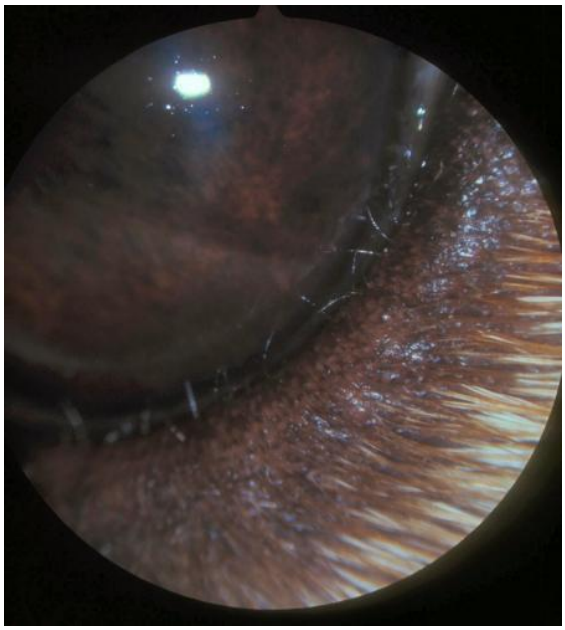


Figure 5: Distichiasis of the lower eyelid in a dog (27).

4.2.2 Clinical symptoms

Distichiasis will result in irritation, manifesting itself clinically as increased lacrimation, epiphora, blepharospasm, eyelid swelling, conjunctival hyperaemia, and corneal disease (vascularization, pigmentation, and/or ulceration) (29).

4.2.3 Diagnosis

When diagnosing an animal with distichiasis, it is important to realize that, if distichia cause a clinical problem, they do so from early puppyhood onward (30). Distichiasis can be

best diagnosed through adequate illumination and magnification, and with the use of topical fluorescein stain. The distichia are fine and have the same colour as the adjacent hair coat (29).

4.2.4 Therapy

Distichiasis does not require treatment unless it results in corneal and/or conjunctival damage (27), and is therefore only necessary in 10% or less of affected dogs (29).

Treatment involves either temporary removal of the offending distichia through manual epilation, or permanent destruction of the distichia follicle by electroepilation, cryoepilation. There is also a variety of surgical procedures available (29).

4.2.5 Prognosis

Treatment is difficult, and out of all therapeutic options, only surgical excision of the root of the aberrant lashes has the potential to remove all distichia with only one procedure (30).

In about 10-30% of all cases of distichia, treated with any kind of distichia technique, distichia regrowth occurs as the result of inadequate excision of the distichia follicles. With manual epilation, the chances of regrowth are even higher. With any kind of distichia technique, eyelid margin fibrosis, focal depigmentation of the postoperative eyelid margin (especially after cryotherapy), and entropion are occasional complications (29).

Cryotherapy may result in depigmentation of the eyelid margin but usually re-pigmentation occurs in subsequent months (27). Other complications of cryotherapy include immediate and sometimes excessive eyelid and conjunctival swelling that lasts about 48 hours, depigmentation of the eyelid and lid margin within 72 hours that usually completely re-pigments within 6 months, and occasional distichia regrowth. However, properly performed, eyelid margin scarring and distortion are unlikely with temperatures that do not fall below -25°C. Eyelid temperatures lower than -30C have been associated with permanent pigment loss, necrosis and lid scarring without increased efficacy (29).

As the follicle of the distichia is usually associated with the meibomian gland, loss of the meibomian gland contribution to the pre-corneal tear film, in turn resulting in tear film instability, may occur following surgical treatment or electrolysis. In addition, electrolysis may result in lid scarring (30).

If left untreated, both trichiasis and distichiasis can lead to irreversible blindness (31).

4.3 Entropion

4.3.1 Etiology and pathogenesis

Entropion can be divided into three categories: congenital or developmental, spastic, and cicatricial. The first category of entropion, the congenital or developmental one, is thought to be a combination of inherited conformation and environmental influences, and the condition therefore does not behave as a simple autosomal trait. It is compounded by adjacent areas, such as the nasal folds and redundant facial folds of skin (29).

The degree of entropion can be classified as either mild (margin tilted about 45°), moderate (margin tilted about 90°), or severe (margin tilted about 180°) (32).

In the Chow, entropion of the lower eyelid is more common than entropion of the upper eyelid, and it can be primary as well as secondary, with secondary entropion being caused by excessive facial skin folding.

Entropion will automatically result in a more or less severe form of trichiasis.

Entropion of the lower lid is thought to be the result of a difference in tension between the orbicularis oculi muscle and the malaris muscle, and is influenced by multiple conditions, such as the length of the lid fissure, the conformation of the skull, the orbital anatomy, the gender, and the amount of folds of the facial skin around the eyes (32). It is, however, important to realize that, with the amount of folds of the facial skin varying enormously between different Chow individuals, a Chow with relatively few facial skin folds can have a profound (primary) entropion, while a Chow with many facial skin folds can have no signs of entropion at all.

4.3.2 Clinical symptoms

The Chow develops the entropion at only a few months of age. Occasionally, the male Chow does not develop entropion until adulthood (middle-aged), presumably due to subcutaneous fat deposits (32).

Entropion often comes with conjunctivitis and epiphora, but although the entropion usually occurs unilaterally, conjunctivitis and epiphora can be seen with both eyes. The epiphora causes depigmentation of the inverted lid margin. In the moderate and severe entropion, corneal ulcer, focal superficial keratitis with scarring and pigment, neovascularization and blepharospasm are present (32).

4.3.3 Diagnosis

The anamnesis, in particular information about breed, age and relatives, can make an animal suspect of entropion. In many cases of entropion, blepharospasm and enophthalmus are present, and sometimes corneal lesions, indicative of a more chronic type of entropion, can be seen using the fluorescein test. The Schirmer tear test may provide the veterinarian with information concerning the severity of the entropion, because it will provide the veterinarian with information concerning the amount of tearing of the eye and therefore the irritation level of the entropion and trichiasis. In severe cases of entropion, the patient is incapable of opening the eyes properly due to the amount of pain experienced (32).

4.3.4 Therapy

Since entropion can lead to corneal irritation and possibly even ulceration, the first and major aim of therapy, whether this entails symptomatic or curative therapy, is to protect the cornea from further damage (32).

Several non-surgical methods are available to treat entropion in small animals, such as subcutaneous injections of antibiotics, paraffin, and mineral oil, ‘tacking’, the Quickert-Rathbun procedure, and electrocautery. Non-surgical methods provide temporary eyelid margin eversion and thereby relief from the trichiasis and blepharospasm but have been generally replaced by different surgical therapies, such as the (modified) Hotz-Celsus procedure, the brow-sling, the ‘Y’ to ‘V’ plasty, the combined entropion-distichiasis procedure, the Stades combined entropion-trichiasis procedure, and the face lift/skinfold excision and rhytidectomy. As a rule of thumb, entropion sufficient to produce other ophthalmic diseases, including conjunctivitis, keratitis, and epiphora with dermatitis, is to be corrected surgically. Each available surgical procedure has different indications, success rates and possible complications. Complicated cases, such as combinations of the upper and lower lid entropion, the medial entropion and the lateral canthal entropion, may require more than one type of procedure or even multiple surgeries. In very young puppies, entropion

can be surgically treated with temporary stay sutures or surgical staples left in place for 2 to 3 weeks (27,29).

It is important to realize that any procedure performed to correct an entropion will change the appearance of the animal (32).

4.3.5 Prognosis

The success of the surgery and therefore the prognosis highly depends on the type of entropion present, the severity of the trichiasis present, the time at which the entropion was acknowledged and treated, the kind of sutures, the time of removal of the sutures, the post-operative care lent, and the presence and type of complications during the post-operative period (32). Complications are usually associated with under- and overcorrection of the defect (29).

Especially if entropion surgery is performed in young and growing puppies, another surgical procedure may be necessary to secure a reasonable repair and a cosmetically acceptable and functional eyelid (29).

4.4 Glaucoma

Etiology and pathogenesis

Glaucoma is an ocular condition that is characterized by an increase in intraocular pressure (IOP, >40-60mmHg) due to the inability of the ocular fluid to leave through the iridocorneal angle or the trabecular meshwork of the anterior chamber (conventional outflow, ±85%), and through the uveoscleral network (ciliary body and sub-scleral space, ±15%) (33,34).

4.4.1 Clinical symptoms

According to American research, glaucoma manifests itself clinically when the animal is anywhere between 3 and 6 years of age. It has been observed bilaterally.

Clinical signs can be subdivided into acute (figure 7) and chronic (figure 6). In reality, however, most cases of acute glaucoma are superimposed on chronic glaucoma (33).

Clinical signs of early to moderate chronic

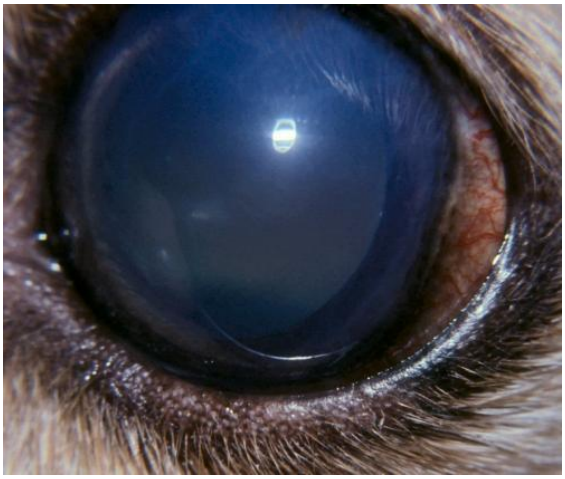
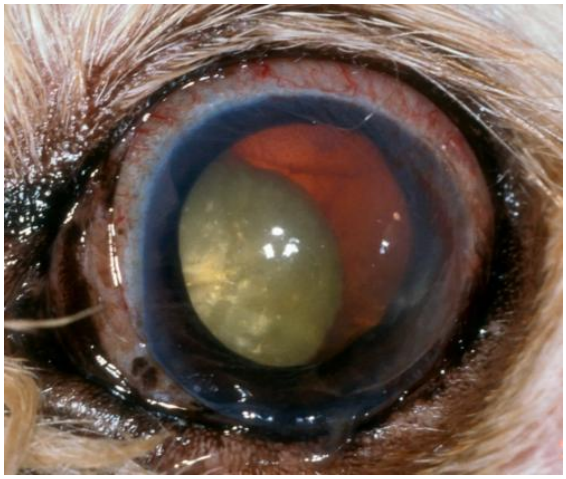


Figure 6: American Cocker Spaniel with chronic glaucoma. Globes with chronic glaucoma often have luxated and cataractous lenses (34).



glaucoma include sluggish to slightly dilated pupils, mild bulbar conjunctival venous congestion, and early enlargement of the eye (buphthalmus or megaloglobus). These signs are so subtle, though, that the animals are generally not taken to the veterinarian. In order to detect early glaucoma, repeated tonometry should be routinely performed as part of the annual, general physical examination (33).

Clinical signs of acute glaucoma include a dilated, fixed, or sluggish pupil, bulbar conjunctival venous congestion, corneal oedema, and a firm globe. Prolonged increases of IOP result in secondary enlargement of the globe, lens displacement, and breaks in Descemet membrane (corneal striae). The animals experience pain, which manifests itself clinically as behavioural changes and occasional periorbital pain. The increased IOP will ultimately causes intraocular damage (including retinal and optic disk destruction), resulting in blindness (33).

4.4.2 Diagnosis

Diagnosis and classification of glaucoma require observation of clinical signs, combined with measurement of the IOP through tonometry, examination and visualisation of the iridocorneal angle and anterior ciliary cleft through gonioscopy, and detection of intraocular pressure-related damage to the retina and optic disk through ophthalmoscopy (direct as well as indirect) (33).

Newly developed electrophysiologic techniques such as pattern electroretinograms and visual evoked potentials have made it possible to estimate the amount of damage to the retinal ganglion cells and their axons and appear to be sensitive indicators of glaucoma-related destruction of these cells. In addition, new, clinical high-resolution imaging techniques such as ultrasound biomicroscopy for anterior segment changes and optical coherence tomography for retinal and optic nerve head changes have permitted non-invasive yet detailed intraocular examinations (33).

4.4.3 Therapy

The two goals of therapy are to rapidly lower the IOP and to, at the same time, preserve as much vision as possible (34).

As gonioscopy is the basis for classification of all glaucomas, it is used to determine the most appropriate medical and surgical treatment. The choice of treatment, usually a combination of both medical and surgical therapy, is hereby based on the progressiveness of the iridocorneal angle closure (33).

Medical treatment, for short- and long-term management of open-angle glaucoma as well as initial control of narrow and closed-angle glaucoma, consists of the administration of miotics, topical and systemic carbonic anhydrase inhibitors, prostaglandins, osmotics, and β-blocking adrenergics. Short- and long-term management of narrow and closed-angle glaucoma requires supplemental surgery, which can include filtering procedures, anterior chamber shunts, cyclocryotherapy, or laser transscleral cyclophotocoagulation. Short- and long-term management of end-stage glaucoma, which comes with buphthalmus and blindness, also requires surgery (intrascleral prosthesis, enucleation, cyclocryothermy, or intravitreal gentamycin combined with dexamethasone) (33).

4.4.4 Prognosis

Because the filtering fistulas eventually scar over and fail, surgical procedures traditionally only provided short-term resolution. With the development of anterior chamber shunts, improved results have been obtained (33).

Expert opinions

When it comes to cataract and distichiasis, ophthalmologic experts at the Utrecht University Clinic for Companion Animals agree

with up to date literature by stating that both disorders are relevant but definitely not of major importance to the Chow breed, with only a few cases of cataract and distichiasis being reported annually at the Utrecht University Clinic for Companion Animals. The same ophthalmologic experts state that entropion, on the other hand, is very commonly diagnosed in the Dutch Chow, thereby again agreeing with up to date literature.

As for glaucoma, the ophthalmologic experts disagree with both up to date literature and American research since they only sporadically diagnose a Chow with this disorder and therefore do not consider glaucoma to be Chow-related.

NCCC data

Despite the low number of Dutch Chows that is diagnosed with cataract, distichiasis, and/or glaucoma, the NCCC breeding-regiment demands that all Chows used for breeding be screened for all three ophthalmologic conditions and recommends that one of the two partners be completely clean. Screening for entropion is also mandatory according the NCCC breeding-regiment but since the NCCC considers this disorder to be the overall number one congenital disorder in the Chow, this might not come as a surprise.

Conclusions

Since entropion is the only condition that is thought to be of major importance by not only ophthalmologic experts at the Utrecht University Clinic for Companion Animals, but also by American research, up to date literature, and the NCCC, this condition is the only ophthalmologic condition that will be placed in the A-category. Cataract and glaucoma are also thought to be important breed standard associated disorders by both American research, up to date literature, and the NCCC, but are thought to be of minor importance by ophthalmologic experts at the Utrecht University Clinic for Companion Animals, placing these two disorders in category B. With only the NCCC breeding-regiment expressing some concerns about the Chow's predisposition for distichiasis, and both up to date literature and the ophthalmologic experts claiming that the condition is no more relevant to the Dutch Chow, distichiasis will be placed in the C-category.

General Conclusions

The Chow-Chow, like any other breed, has a tendency to develop certain breed standard associated disorders and inherited diseases. According to a literature search, the professional opinion of organ specialists – all internationally recognized diplomats of the respective European Colleges of Specialization – at the Utrecht University Clinic for Companion Animals, and the secretary of the NCCC, the disorders and diseases being most relevant to the Dutch Chow, in alphabetical order, are: cataract, cerebellar hypoplasia, colour dilution alopecia, the cranial cruciate ligament rupture, demyelinating disorders, distichiasis, elbow dysplasia, entropion, glaucoma, hip dysplasia, patellar luxation, and spondylosis. Some of those disorders and diseases bear significant consequences for the animals health and overall wellbeing, whereas others will generally cause little to no harm, the development of complications excluded in this assumption.

Based on a literature search, expert opinions and information provided by the secretary of the NCCC, the breed standard associated disorders and inherited diseases described in this thesis were categorized based on their

relative importance to the Dutch Chow. The categorization is presented in table 1.

Especially concerning those breed standard associated disorders and inherited diseases placed in category A, a gradual reduction of the incidence of these disorders and diseases would be beneficial to the health status of the Chow breed. The first steps in this direction have already been taken by introducing breeding protocols and regiments, with the extent to which they are implemented and mandatory depending on the breed and the breeders organization's demands. The introduction of genetic parameters, such as estimated breeding values, would be another major step in growing towards a healthier breed. Of great importance in selective breeding is that the genetic health of the population is to be comprised at all times.

Category	Breed standard associated disorder / Inherited disease
A	Cranial Cruciate Ligament Rupture Entropion Patellar luxation
B	Cataract Colour dilution alopecia, CDA Glaucoma Spondylosis
C	Cerebellar hypoplasia Demyelinating disorders Distichiasis Elbow dysplasia Hip dysplasia

Table 1: The Dutch Chow-Chow's breed standard associated disorders and inherited diseases, categorized according to relevance.

Discussion

With regard to the categorization of the described disorders and diseases, it is important to realize that many cases, for various reasons, remain unreported in literature as well as at the Utrecht University Clinic for Companion Animals, and that the internationally recognized diplomats of the respective European Colleges of Specialization at the Utrecht University Clinic for Companion Animals consulted see only a fraction of all diseased Dutch Chow-Chow's, consisting mainly of the more severe cases. Therefore, the categorization might not fully be accurate and representative of the actual current health status of the Dutch Chow-Chow.

To improve the reliability of the categorization of the breed standard associated disorders and inherited diseases of the Dutch Chow-Chow described in this thesis, the relative frequencies of these disorders and diseases could be determined by consulting the clinical database of the UKG. It should however be kept in mind that the UKG database only contains those cases that are treated by the veterinarians at the Utrecht University Clinic for Companion Animals and that therefore this database is not representative of the entire Dutch Chow-Chow population. The Expertise Centre for Genetics of Companion Animals of the University Clinic UKG has set up a national system for measuring incidences of diseases in all dog breeds, collected in a central internet based database at Utrecht University which connects all first line veterinary clinics in the Netherlands. This new system will produce reliable incidences of disease, and the advice is to await these results which will come in 2016 and following years.

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