Humeral Intracondylar Fissure in Dogs

Andy P. Moores, BVSc, FRCVS

KEYWORDS

• Humeral condyle • Intracondylar fissure • Incomplete ossification • Elbow • Dog

KEY POINTS

- In most dogs this condition is thought to be a stress fracture of the humeral condyle, and so the descriptive term "humeral intracondylar fissure" is preferred to "incomplete ossification of the humeral condyle."
- Humeral intracondylar fissure has been reported in several breeds but is most commonly seen in spaniel breeds.
- Humeral intracondylar fissure predisposes dogs to condylar fractures that may occur with minimal or no trauma. It can also cause lameness without fracture.
- Computed tomography is more sensitive than radiography for diagnosis.
- Historic high surgical complication rates may be reduced by modifying technique and careful execution.

INTRODUCTION

Humeral intracondylar fissure (HIF), previously known as incomplete ossification of the humeral condyle (IOHC), is characterized by the presence of a midsagittal fissure in the humeral condyle, which may completely or partially separate the two halves of the humeral condyle. Such fissures weaken the humeral condyle and thus HIF predisposes affected dogs to complete condylar fractures. HIF may also cause clinical signs of lameness and elbow pain in its own right, without complete fracture. This article reviews the current understanding of this condition and treatment options.

HISTORY

In the 1980s, reviews of humeral condylar fractures in dogs indicated that spaniel breeds were at increased risk of these fractures compared with other breeds. In a study of 133 humeral condylar fractures from the United Kingdom, Denny[1] reported that 35% were in spaniel breeds with most being English Springer Spaniels (23% of all humeral condylar fractures). It was also recognized that these fractures often

Anderson Moores Veterinary Specialists, Bunstead Barns, Poles lane, Hursley, Winchester, SO21 2LL, United Kingdom
E-mail address: andy@andersonmoores.com

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occurred during normal activity. In a study of 20 dogs from the United States that fractured their humeral condyle during normal activity, Vannini and colleagues[2] reported that 11 (55%) of the dogs were Cocker Spaniels. It is worth noting that the breed referred to as the Cocker Spaniel in North America, is known as the American Cocker Spaniel in Europe to distinguish it from the European Cocker Spaniel, which is similar but has different breed standards. For the remainder of this review the two breeds are referred to as the American Cocker Spaniel and the Cocker Spaniel. Some of the American Cocker Spaniels identified by Vannini and colleagues[2] had been lame before fracture and some had radiographic evidence of remodeling of the lateral epicondylar crest.

The authors of both of these studies were unable to identify why these breeds were at increased risk of humeral condylar fracture but they proposed that it may be caused by a conformational issue or weakness in the distal humerus.[1,2] Denny[1] additionally proposed that it may be representative of English Springer Spaniels being active dogs that are frequently worked over rough ground.

The first description of HIF was made by Meutstege in 1989.[3] He described four dogs with chronic intermittent forelimb lameness. All four had a fracture line or fissure evident between the two halves of the humeral condyle, which was only visible on oblique craniocaudal radiographs. One of these dogs fractured the humeral condyle a short time after diagnosis and all four progressed well after lag screw fixation.

Marcellin-Little and colleagues[4] published the first detailed description of this condition, which they called IOHC. Because the term IOHC implies a developmental cause and more recent reports support this condition being the result of a stress fracture in some dogs,[5–7] the descriptive term HIF has been proposed and is used here.

ETIOPATHOGENESIS

Mineralization of the cartilaginous anlage of the humeral condyle is initiated at two separate centers of ossification at around 14 $\pm$ 8 days after birth. One goes on to form the capitulum and the lateral part of the humeral condyle and the other to form the trochlea and the medial part of the humeral condyle (**Fig. 1**). As mineralization progresses, the two centers of ossification are separated by a thin cartilaginous plate until they unite at 8 to 12 weeks of age.[8] The location of the fissure in dogs with HIF corresponds to the position of the cartilaginous plate that separates the two centers of ossification and thus in early reports of this condition it was proposed to be the result of the failure of the two centers of ossification to unite, hence the initial name of IOHC.[4]

The incomplete ossification theory has not adequately explained the clinical findings in many dogs with HIF. Biopsies from a small number of dogs identified fibrous tissue at the fissure, rather than the cartilaginous tissue that might be expected.[4] Also, clinical signs are often first recognized in adult dogs,[4,9–11] which would be unexpected if the weakness in the humeral condyle is present from a young age. Finally, failure of the two centers of ossification to unite does not fully explain complete HIFs, which extend to the supractrochlear foramen, because the cartilaginous plate does not extend that far proximal (see **Fig. 1**).

Over the past 10 years or so, with the increasing use of cross-sectional imaging, it has become apparent that, at least in some dogs, HIF is a form of stress fracture. Authors have reported not only the propagation of condylar fissures over time but also the development of intracondylar fissures in previously normal humeral condyles.[5–7,12] Additional support for the stress fracture theory comes from the adult onset of clinical signs in many dogs and the lack of association between fissure size and fracture risk, which would be consistent with the fissure size getting larger over time. If the fissure size

Fig. 1. Craniocaudal radiograph of the distal humerus from a 7-week-old Labrador.

was static then dogs with small partial fissures would be expected to be at lower risk of complete condylar fracture than dogs with complete fissures, but the evidence does not support this.[7,13] Assuming that HIF does represent a stress fracture, there is no evidence that these are insufficiency fractures, that is, associated with poor bone quality. Affected dogs are not predisposed to fractures elsewhere, which would be expected of a generalized bone disease. On the contrary, computed tomography (CT) imaging of HIF and surgical findings during open fracture repair of condylar fractures associated with HIF, confirm dense sclerotic bone adjacent to HIF lesions,[13–15] which is a characteristic of stress fractures in other locations.[16] A stress fracture in the presence of normal bone (ie, a fatigue fracture) implies repetitive mechanical overload. This might be expected in a breed, such as the English Springer Spaniel, which is known as an active breed and that is often worked as a gun dog. The American Cocker Spaniels reported with HIF, however, have been described as indoor dogs with a sedentary lifestyle.[13]

HIF does not universally present in adult dogs. HIF has been reported in dogs as young as 4 months of age.[7,11] It seems more likely that dogs of this age would have a developmental HIF (ie, incomplete ossification) rather than a stress fracture, so it is feasible that both theories are valid and HIF may result from two different mechanisms.

A microangiographic study of the humeral condyles of four American Cocker Spaniels without HIF reported that American Cocker Spaniels had reduced vascular density in the humeral condyle compared with mixed-breed dogs.[17] The significance of this finding in relation to HIF is unclear.

Irrespective of whether HIF develops as a failure of ossification or as a stress fracture, there may be a common underlying conformational issue that predisposes to both scenarios. In a CT survey of the elbows of English Springer Spaniels without a history of forelimb lameness, 50% of dogs had evidence of medial coronoid process pathology.[18] The same study reported an incidence of HIF of 14%. The high incidence of medial coronoid process pathology in a breed susceptible to HIF raises the intriguing possibility that the two conditions may share a common developmental or conformational abnormality. Radioulnar incongruity, for example, is a conformational abnormality that could plausibly predispose to HIF. There is conflicting evidence in relation to radioulnar incongruity and HIF, with one paper showing no evidence of incongruity in dogs with HIF[18] and another that reported significantly greater humeroulnar incongruity at the base and at the apex of the medial coronoid process in elbows with HIF, compared with unaffected elbows.[15]

A conformational abnormality of the elbow may have the effect of distorting weight-bearing forces acting on the elbow and predisposing the humeral condyle to either failure of the two centers of ossification to fuse or, in older dogs, a stress fracture. Arthroscopic findings suggest that it is not a pure axial force that stresses the humeral condyle. Eleven dogs with complete HIF were examined arthroscopically by the author, before placement of a transcondylar screw. The intracondylar fissure of each elbow was visualized arthroscopically while the elbow was put through a series of standardized manipulations. With the elbow at a weight-bearing angle, internal rotation of the lower limb caused the intracondylar fissure to visibly widen in 9 of 11 elbows. Pure axial force directed along the antebrachium and external rotation of the lower limb caused no visible change in the intracondylar fissure (A.P. Moores, unpublished data, 2020). The widening of the fissure seen during internal rotation is a consequence of the anconeal process putting a lateralized force on the lateral epicondyle and/or the medial coronoid process imparting a medially directed force on the trochlea (medial half of the humeral condyle). Sudden turning (which causes torque on the lower limb) may therefore play a greater role in stressing the humeral condyle than simple axial loading of the humeral condyle.

Pedigree analysis of eight affected American Cocker Spaniels has suggested that HIF may have a genetic basis with a recessive mode of inheritance in this breed.[4]

PRESENTATION

Breeds predisposed to HIF include the spaniel breeds (particularly the English Springer Spaniel in the United Kingdom and the American Cocker Spaniel in the United States, but other spaniel breeds may also be affected) and the German Wachtelhund,[11] which is also known as the German Spaniel. Other reported breeds include the German Shepherd Dog, Yorkshire Terrier, Tibetan Mastiff, Rottweiler, English Pointer, Siberian Husky, and Labrador Retriever.[9,14,19,20] Most studies report that male dogs are more commonly affected than female dogs.[4,7,11,21]

Dogs with HIF present in one of three ways. They may present with a weight-bearing forelimb lameness, they may present with a humeral condylar fracture associated with HIF, or they may present without lameness where HIF has been diagnosed as an incidental finding.

HIF should be considered in predisposed breeds that present with a forelimb lameness localizable to the elbow. The lameness is weight-bearing and may be mild and intermittent or be persistent and more severe. Elbow discomfort is most evident on full extension and there may also be discomfort on palpation over the lateral epicondylar crest. Often the lameness is poorly responsive to nonsteroidal anti-inflammatory drugs.

DIAGNOSIS

Diagnosis of HIF requires demonstration of a fissure in the midsagittal plane of the humeral condyle. Partial fissures extend part-way across the humeral condyle and originate from the articular surface.[15] Complete fissures extend across the entire humeral condyle. High-quality craniocaudal radiographs of the elbow may demonstrate the fissure (Fig. 2), which is radiolucent, although often the fissure is not evident unless the x-ray beam is directed exactly parallel to it. Several craniocaudal projections may therefore be required, each taken at slightly different angles of rotation. It has been suggested that a 15° craniomedial-caudolateral oblique projection is most likely to demonstrate the fissure and that rotation of the condyle greater than 5° away from this results in an inability to detect the fissure.[4] It is important that HIF is not mistakenly diagnosed based on seeing a Mach line, a visual anomaly created by the superimposition of one bone edge on another and that can appear as a radiolucent line through the condyle (Fig. 3). New bone, or a periosteal reaction, along the lateral margin of the lateral epicondylar crest may be seen in association with HIF (Fig. 4), which presumably represents a stress-adaptation of the lateral epicondylar crest caused by weakness in the condyle.

CT is the preferred diagnostic tool for HIF. Good quality transverse slices (typically 0.6–1.0 mm) readily demonstrate the hypoattenuating fissure (Fig. 5). In a CT study of 38 elbows with HIF all but two fissures were irregular (described as saw-tooth) rather than straight and all fissures were bordered by hyperattenuating bone (sclerosis). All of the partial fissures originated from the articular surface.[15] MRI also identifies HIF and is more sensitive than radiography.[12] If cross-sectional imaging is not available and radiography fails to identify HIF, many fissures are visible arthroscopically as an irregular

Fig. 2. Craniocaudal radiograph of the elbow from a 17-month-old English Springer Spaniel with humeral intracondylar fissure (*arrowhead*).

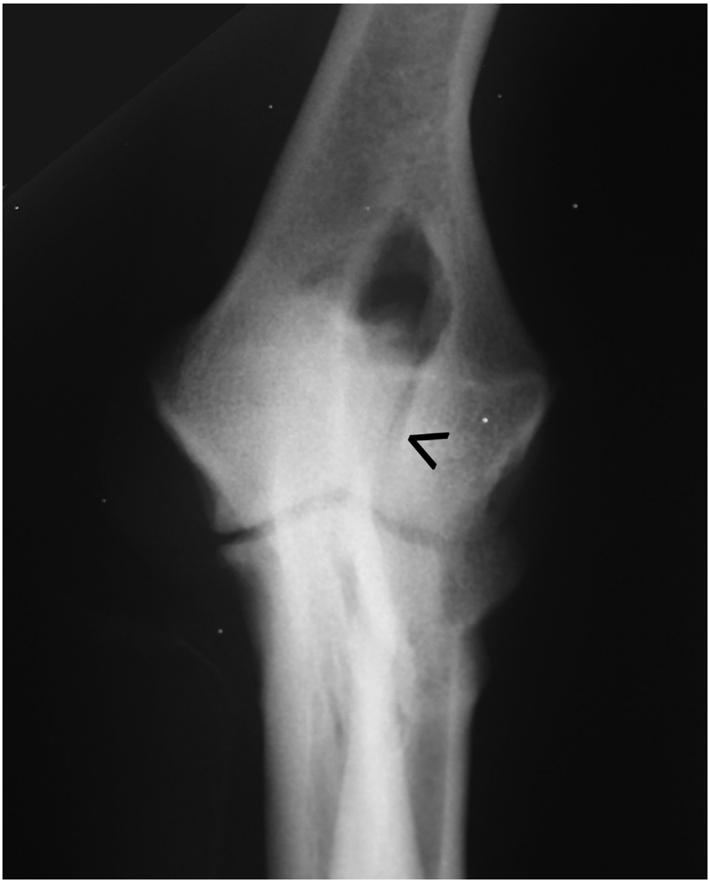

Fig. 3. Craniocaudal radiograph of the elbow. There is a Mach line present (*arrowhead*), because of superimposition of the axial edge of the lateral epicondyle and the lateral aspect of the anconeal process and olecranon.

midsagittal defect in the articular cartilage of the humeral condyle (Fig. 6),[11] although a CT-confirmed case without arthroscopic evidence has been reported.[22]

TREATMENT

The Dog with Lameness but No Fracture

These dogs are generally treated with a transcondylar screw to bridge the fissure and strengthen the condyle. The intention is to improve or eliminate the lameness and also to reduce the risk of future condylar fracture. A variety of implants have been described for this purpose. Initial reports described using standard AO-style cortical screws as either positional or lag screws (Fig. 7).[9,11] Although initial reports described reasonable outcomes, it was the experience of many surgeons that transcondylar screw placement is associated with a significant risk of complications. A multicenter UK study reported a 59.5% total complication rate after screw placement.[20] Seroma (32% incidence) and surgical site infection (30% incidence) were the two most common complications. The Labrador Retriever was at increased risk of a complication compared with other breeds and increasing body weight and the placement of the

Fig. 4. Computed tomography three-dimensional reconstructions of the left and right elbows (caudal aspect) from a 3-year-old Working Cocker Spaniel with right-sided humeral intracondylar fissure. Note the remodeling of the lateral epicondylar crest of the affected elbow.

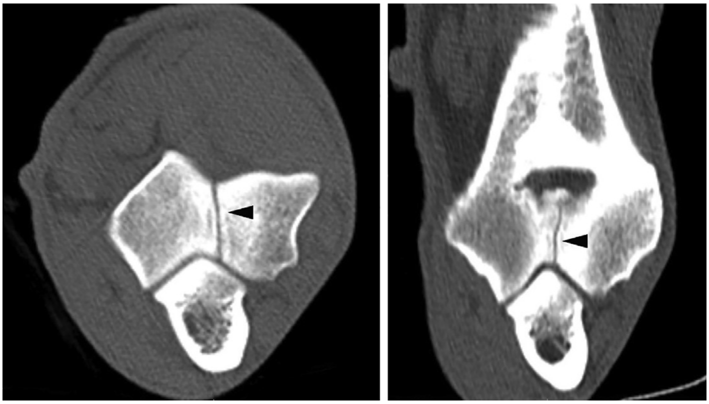

Fig. 5. Computed tomography scans (transverse on the *left*, reformatted frontal plane on the *right*) of the humeral condyle from a 5-year-old English Springer Spaniel with humeral intracondylar fissure (*arrowhead*).

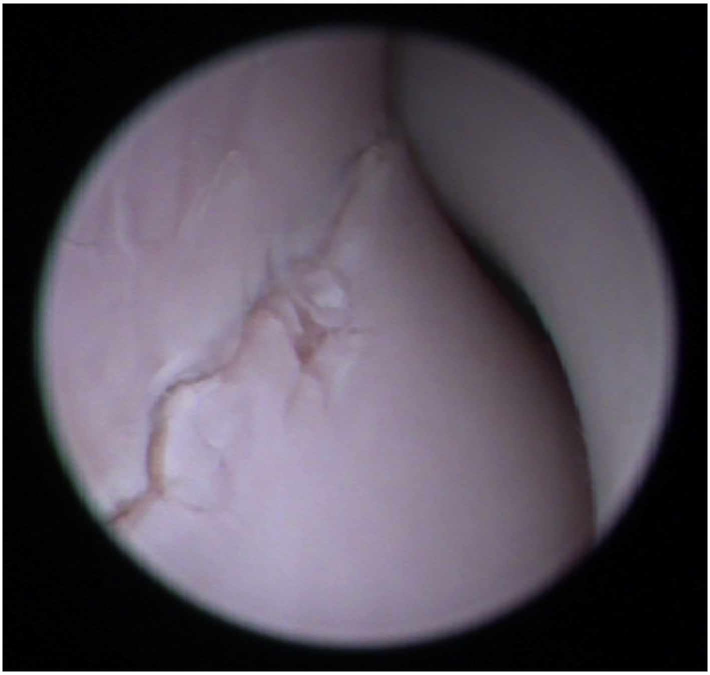

Fig. 6. Arthroscopic image of a humeral intracondylar fissure. Right elbow, medial portals, anconeal process on the right.

screw as a positional screw were risk factors for surgical site infection. Another study reported a surgical site infection rate of 42%.[21] At the time that the cases in these studies were managed, it was standard practice among UK surgeons to place transcondylar screws from lateral-to-medial and it is likely that this approach predisposes to wound complications and infection. In a study that compared both approaches, four of eight elbows treated via a lateral approach had a major complication, whereas zero of six treated via a medial approach did. This approached, but did not reach, statistical significance ($P = .085$).[10] Other studies have reported surgical site infection rates of 6% and 14% with a medial approach, which compare favorably with studies where a lateral approach was used.[23,24] The author's personal experience is that the lateral approach is associated with a significant risk of wound complications and surgical site infection, and that since adopting the medial approach these complications have not only been much less common but when they do occur, they have also resolved more readily. It is unclear why the lateral approach seems to predispose to such complications but poor soft tissue cover laterally and contact of the lateral aspect of the elbow with the ground when lying down are possibilities.

Transcondylar screws can be placed blind but this risks inadvertent intra-articular screw placement. It is preferable to use a self-aiming drill guide or intraoperative fluoroscopy to guide screw placement.[23,25] Safe entry/exit points for the medial and lateral epicondyles have been described.[26] Relative to the diameter of the humeral condyle (HCD) at its isthmus, its narrowest part, the medial point is $0.3 \times$ HCD cranial and $0.2 \times$ HCD distal to the most proximal point of the medial epicondyle and the lateral point is $0.3 \times$ HCD cranial and $0.3 \times$ HCD distal to the most proximal point of the lateral epicondyle. Patient-specific three-dimensional printed drill guides have

Fig. 7. Postoperative radiograph of a transcondylar 4.5-mm cortical lag screw. Note the remodeling of the lateral epicondylar crest (this is the same dog as in **Fig. 4**).

also been described.[27] If a lagged implant is used, then the length of the glide hole is judged from preoperative imaging and drill stops are used to avoid inadvertent overdrilling.

Surgical treatment does not always result in bone healing across the fissure. The incidence of a persistent fissure after surgical management varies between reports. Collated data from several reports suggest that around 75% of fissures reduce in size or heal completely after conventional surgical management (**Table 1**).

Care should be taken in interpreting fissure healing data. The radiographic assessment of healing could be unreliable because of the difficulties of demonstrating fissures radiographically. CT assessment is preferable but could be hindered by implant-associated artifact. Finally, the act of compressing the fissure may alter its appearance, making comparisons with preoperative imaging problematic.

Failure (breakage) of transcondylar implants is well-recognized as a complication of HIF treatment with a reported incidence of 2.5% to 10%.[9,11,20,21,23] The reported incidence of implant failure is affected by the length of follow-up and whether imaging was performed or not (not all failed implants result in a recurrence of clinical signs[21]). The average time after surgery at which a failed implant is identified is 24 months (range,

Table 1
Reported data for persistence of a fissure after surgical treatment of HIF

		<3-mo Follow-Up			>3-mo Follow-Up		
	Imaging Technique	**Fissure Unchanged**	**Fissure Smaller**	**No Fissure**	**Fissure Unchanged**	**Fissure Smaller**	**No Fissure**
Meyer-Lindenberg et al,[11] 2002	Radiograph				2		5
Butterworth & Innes,[9] 2001	Radiograph	1	4			2	3
Moores et al,[10] 2014	CT		1		3	1	2
Chase et al,[21] 2019	Radiograph				6 (fissure present, but does not state if smaller or not)		3
Combined (Chase et al excluded)		1	5		5	3	10

Data from Refs.[9–11,21]

11–48 months).[9,11,28] Scanning electron microscopy of retrieved failed screws has revealed a multidirectional pattern of fatigue fracture that is presumed to result from persistent instability in the humeral condyle despite screw placement.[28]

One strategy to mitigate the risk of screw failure is to use the largest screw that can be safely placed across the humeral condyle. As a guide, a screw with a thread diameter of 30% to 50% of the diameter of the narrowest part of the humeral condyle is used.[14] Care should be taken not to overtighten AO cortical-style screws with domed screw heads; the author has seen a small number of medial epicondylar fissure fractures develop as screws are tightened, sometimes with an audible crack as the fissure occurs. These fractures initiate underneath the screw head, are nonarticular, and do not seem to require any specific treatment. (Jenkins G, Moores AP: Medial epicondylar fissure fracture as a complication during stabilization of HIF. Submitted for publication.)

Adult English Springer Spaniels typically require a 4.5-mm screw. Fully threaded 4.5-mm cortical screws can be used but these can break.[28] To provide additional strength at the midpoint of the humeral condyle the 4.5-mm shaft screw (Veterinary Instrumentation, Sheffield, UK) is used as a transcondylar implant.[10] This has a solid 4.5-mm diameter section that bridges the fissure (**Fig. 8**). The area moment of inertia (a geometric measure of a structure's resistance to bending) of the shaft of the 4.5-mm shaft screw is five times greater than that of a 4.5-mm cortical screw of the same material.[29,30] The author's experience is that fatigue failure of the 4.5-mm shaft screw is rare. The reduced surface area of the shaft screw compared with a fully-threaded cortical screw has, however, introduced an additional complication, namely screw back-out/loosening that is not associated with infection. Careful technique and screw length selection are important to maximize the engagement of the shaft screw threads in bone and thus reduce the risk of the screw backing out.[10]

Titanium has better fatigue resistance than stainless steel, although stainless steel is stronger. There may therefore be benefits to using titanium implants for treating HIF, although there are no studies comparing the two materials to confirm this.

Rather than simply using the largest implant possible, another strategy to avoid implant failure is to focus on encouraging bone healing across the fissure. Transcondylar bone tunnels used alone without an additional transcondylar screw did not result in bone healing in one report.[19] In another report bone tunnels were created alongside a transcondylar screw but bone healing at the tunnels was not assessed.[9] Autogenous corticocancellous dowels placed alongside a transcondylar screw resulted in bone healing at the site of the dowel in six dogs 11 to 16 weeks postoperatively.[31]

Implants specifically designed to manage HIF and to encourage bone healing have been described. One such implant has a 3-mm cannulated core designed to accept autogenous cancellous bone graft, with fenestrations in the implant to allow vascular access.[32] Another implant has a central 3-mm nonthreaded core that is placed within a 6-mm drill hole that crosses the fissure. The 1.5-mm void around the shaft of the implant is filled with demineralized bone matrix putty to encourage local bone healing.[33]

In managing HIF there will always be a trade-off between the amount of bone that can form across the fissure and implant size; strategies that aim to encourage large areas of the fissure to heal necessitate smaller implants. Strategies that rely on encouraging bone healing at the expense of implant strength are potentially flawed if the underlying cause of the fissure is a stress fracture and if the underlying stresses acting on the humeral condyle remain. A transcondylar implant may load-share sufficiently with any new bone that forms to avoid fatigue fracture of the new bone and the implant, but the ideal ratio of implant to new bone is not known. Currently, there are no

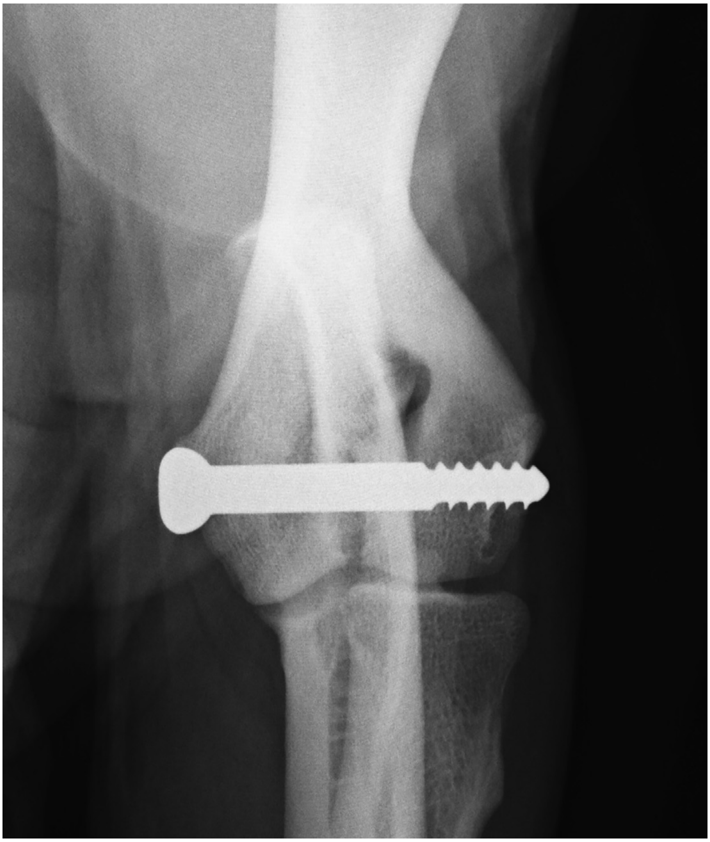

Fig. 8. Postoperative radiograph of a transcondylar 4.5-mm shaft screw, placed in a 2-year-old English Springer Spaniel.

long-term data to confirm the longevity of new bone that forms across the fissure with the novel screw types described previously.

Assessing studies that report outcomes after surgical management of HIF is problematic because of variable follow-up times and methodologies. Furthermore, breeds predisposed to HIF can also be affected by other conditions of the elbow, so long-term lameness may not be directly attributable to HIF in some dogs.[15,18,19] Nonetheless, outcome data with a minimum of 6-month follow-up, collated from several studies, indicate that around 70% of cases are expected to have good or excellent long-term function.[9–11,21,23]

The Dog with Fracture Associated with Humeral Intracondylar Fissure

Preexisting HIF should be suspected when dogs of at-risk breeds present with humeral condylar fractures after minor or no trauma. A history of weight-bearing lameness preceding fracture and/or HIF in the contralateral limb further support preexisting HIF. Confirmatory evidence includes hyperattenuating/sclerotic bone bordering the condylar part of the fracture or periosteal new bone/remodeling at the lateral epicondylar crest, evident on preoperative CT or at surgery.

Condylar fractures associated with HIF should be managed along the lines of all articular fractures; namely, accurate anatomic reduction and rigid fixation, typically using a transcondylar compression screw with additional epicondylar fixation. Surgeons should consider that the condylar part of the fracture may not heal[34] and a transcondylar implant that can withstand a prolonged period of stress should be chosen, similarly to nonfractured HIF.

Intracondylar (Y/T) fractures are typically double plated.[35] Lateral humeral condylar fractures associated with HIF are plated along the epicondylar crest rather than relying on an epicondylar Kirschner wire. Plating lateral humeral condylar fractures in this way should reduce the stress on the transcondylar implant and is associated with fewer complications than using a Kirschner wire, particularly in adult dogs.[34] Medial humeral condylar fractures are less common and are managed with epicondylar crest lag screws and/or plates.

The Dog with Nonsymptomatic Humeral Intracondylar Fissure

HIF may be diagnosed as an incidental finding, such as in the contralateral humeral condyle during the imaging assessment of a dog with a condylar fracture. In one survey 6 of 14 (43%) dogs presenting with a unilateral condylar fracture had a CT diagnosis of HIF in the contralateral humerus.[36]

In a study of 34 cases of nonsymptomatic HIF treated nonsurgically, six (18%) went on to fracture at a mean of 14 months after diagnosis (range, 5–24 months), and a further two cases had a transcondylar screw placed at 11 and 17 months to manage a progressive lameness presumed to relate to the HIF. The mean follow-up for cases not requiring surgery was 56 months (range, 29–79 months). Fissure size, body weight, age, and presence of a contralateral fracture were not associated with fracture.[7] These data suggest that a low number of nonsymptomatic HIFs will fracture following diagnosis and that if they do fracture then it is likely to be within 2 years of diagnosis, which is consistent with other data.[13]

The author's approach for nonsymptomatic HIF is to discuss the previously mentioned risks, and the risks of surgical management, with each owner. Some owners prefer early surgery to mitigate the risk of condylar fracture. Many prefer to avoid surgery. For those that decline surgery and have partial HIF there may be some value in a 4- to 6-month follow-up CT examination to assess if the fissure is progressing or not, with surgery being considered in those cases where it is. In a small number of cases followed by the author in this way the fissure has healed on follow-up CT examination.

It is not known if dogs with symptomatic HIF would have a similar risk of fracture to dogs with nonsymptomatic HIF. Most owners opt for surgical management to address their dog's lameness and so long-term data do not exist for conservatively managed symptomatic cases. It has been proposed that the pain associated with HIF relates to abnormal stresses on the lateral epicondylar crest,[9] and if this is the case then symptomatic dogs would be expected to be at a greater risk of fracture than nonsymptomatic dogs.

REVISION STRATEGIES

Removal of the screw tip of a transcondylar screw that has broken is problematic and is made a lot easier if a slightly longer screw than is needed is placed at the initial surgery, so that the tip of the screw can be gripped with pliers should the screw break. If the screw tip is buried and this is not an option then there are proprietary trephine systems available (eg, from DePuy Synthes) that can make the task of removal simple. Alternatively, bone is burred away from around the screw tip until a pair of pliers can be used to grip it.

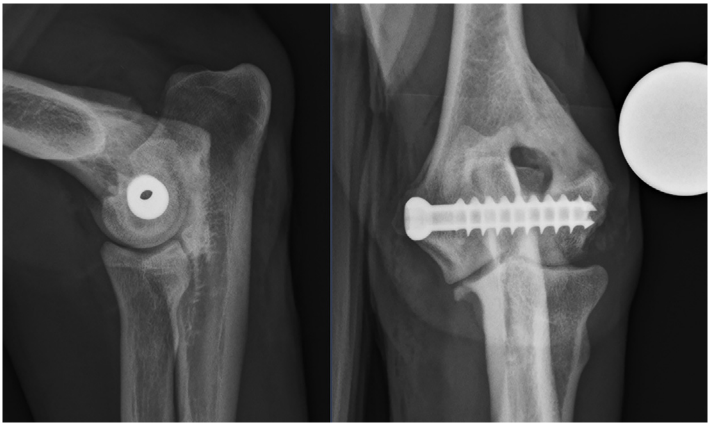

Fig. 9. Postoperative radiographs of a transcondylar 7.3-mm cannulated screw in a 4-year-old English Springer Spaniel, placed after staged removal of an infected shaft screw.

The simplest approach to a screw that has backed-out and has no bone loss around it and no infection present, is to retighten the screw. Sometimes the screw backs-out a second time in which case another solution should be considered, but often the screw remains secure the second-time around.

If a screw needs to be replaced, then as long as initial screw placement was central within the humeral condyle, a larger screw can usually be placed. For example, a fully-threaded 5.5-mm cortical screw (4.0-mm core) can be used to replace a 4.5-mm screw. This is particularly useful if there is minor bone loss around the original implant. If the bone loss is significant then even larger screws may be an option and the author has successfully replaced a 4.5-mm screw with a 7.3-mm cannulated screw (De Puy Synthes) in an English Springer Spaniel (Fig. 9). If there is no bone loss, then an alternate option is to replace the screw with a longer screw of the same size and secure the screw with a nut on the lateral aspect of the condyle (if medial screw placement).

It may be possible to resolve implant-associated infection with medical management only, but in some cases implant removal is required.[21] Some dogs can have a good outcome despite implant removal.[11] For those that remain lame or if the owner prefers to pursue further surgery to mitigate the risk of fracture, staged removal and replacement of the transcondylar implant is considered. The author has managed a septic and loose transcondylar screw in one dog with a lateral epicondylar crest plate alone (ie, with no transcondylar screw), with a resolution of lameness and no long-term complications.

CLINICS CARE POINTS

- Humeral intracondylar fissure (HIF) should be considered in spaniel breeds presenting with forelimb lameness and elbow pain.
- Computed tomography is more sensitive than radiography for diagnosis.
- Symptomatic cases (without complete condylar fracture) are treated with a transcondylar screw, which should be around 30% to 50% of the diameter of the isthmus of the humeral condyle.

- A medial approach is thought to reduce the complication rate and application of the screw as a lagged screw has been associated with a reduced risk of surgical site infection.
- Complete condylar fractures associated with HIF should be treated with standard AO principles of articular fracture repair.
- Lateral humeral condylar fractures should be repaired with a transcondylar compression screw and additional epicondylar crest plate, rather than a lateral Kirschner wire.
- Cases of nonsymptomatic HIF diagnosed as an incidental finding have an 18% risk of fracture, which typically occurs within 2 years of diagnosis.

DISCLOSURE

The author has no conflicts of interest to declare.

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