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## **Canine Angular Limb Deformity: Diagnosis and Treatment**

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### Introduction

Angular limb deformity (ALD) is a relatively common orthopedic problem encountered in dogs. Many types of deformities have been described based on the plane in which they arise. Angular limb deformity may result in impaired function of the limb due to painful range of motion and dysfunction of adjacent joints, ineffective locomotion from significantly misaligned joints or limb shortening.

### Pathogenesis

Although angular limb deformity may occur in any limb, veterinary surgeons most commonly encounter it in the forelimb. The radius and ulna, which share a strong soft tissue connection via the interosseous ligament, must lengthen at the same rate for normal development of the antebrachium to occur. Disruption of a physis in either bone of the antebrachium may lead to a relative shortening of one bone compared to the other, resulting in ALD and incongruence in the elbow.

Since diaphyseal growth of the ulna occurs almost exclusively from the distal ulnar physis (90-100% of ulnar length arises from the distal ulnar physis) damage to this physis can be problematic. The conical shape and superficial location of the distal ulnar physis make it particularly susceptible to damage (Salter Harris V type fracture). In fact, this physis can be damaged with near normal weight bearing force resulting in disruption of ulnar growth. Often times, trauma that causes disruption of the distal ulnar physis is minor and not detected by the owner at the time of injury. As the animal ages, ulnar growth is halted and the strong tether to the radius via the interosseous ligament inhibits the growth of the radius as well. As a result, radial procurvatum (dorsal bowing of the radius), humeroulnar incongruence, carpal valgus and external rotation of the antebrachium can occur.

### Clinical Findings

Dogs with ALD are presented for evaluation with problems ranging from a subtle lameness to obvious angulation of the affected forelimb. Diagnosis of ALD and humeroulnar incongruence is then confirmed via craniocaudal and lateral radiographs of the affected and contralateral limbs and elbows, respectively. Following diagnosis, the surgeon may face multiple problems which may need to be addressed: 1) humeroulnar incongruence, 2) radial rotational deformity, 3) carpal valgus and 4) radial shortening.

### Diagnosis and Treatment

Depending on the age of the patient, expected continued growth potential of the radius, severity of carpal valgus, severity of radial rotational deformity, and degree of radial shortening, a surgical treatment plan is designed. Extensive pre-operative planning based on orthogonal radiographs or rarely CT scan reconstruction images of the affected limb are performed. Surgical options may include ulnar ostectomy alone, ulnar ostectomy plus radial osteotomy (opening wedge, closing wedge, dome) followed by internal or external fixation, or ulnar ostectomy plus radial osteotomy and radial lengthening via distraction osteogenesis (utilizing circular external skeletal fixation). Humeroulnar incongruence due to shortening of the ulna must be addressed to limit elbow joint articular cartilage damage and progressive osteoarthritis of the elbow. Often times, humeroulnar incongruence can be corrected with a distal ulnar ostectomy which allows for gradual proximal migration of the proximal ulnar segment during weight bearing. If the humeroulnar deficit is severe, active re-alignment with circular external skeletal fixation facilitated bone transport may also be indicated.

### Post-operative Management and Expected Outcomes

Post-operative management including diligent external skeletal fixator care, elbow and carpus range of motion exercises and appropriate confinement with leashed weight bearing walks help provide a successful outcome in these cases. By improving elbow congruence, correcting carpal valgus, correcting radial rotational abnormalities and lengthening the radius when applicable, a functional limb with comfortable range of motion in the elbow and carpus can be achieved.

References available on request