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Radiographic anatomy of developing canine pectoral limb

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The appearance of the ossification centers of the limb bones of puppies, has been described earlier. Hare (1959) studied the appearance of ossification centers in dogs from 4 breeds. Smith and Allcock (1960) stated the pattern of fusion of epiphyses in Greyhounds. Chapman (1965) worked on similar subject in Beagles and mainly concentrated on skeletal maturation, essentially determining the rate and the time of appearance of secondary ossification centers and the age at which closure of the epiphyses occurs. It could be pointed out from these previous contributions that variation in skeletal development was not surprising. However, the time of appearance of ossification centers showed less diversity than their time of fusion.

Studies in various species showed that there might be differences in skeletal development between sexes within a litter and between litters. It was also observed that the method of husbandry would have some control, but still there is much constancy in any aspect of growth.

During the present study, 18 puppies (6 each) of 3 different breeds, viz. German shepherd, Pomeranian and non-descript from various litters were used. These puppies were maintained on food having balanced nutrients.

The puppies were radiographed at set interval of fortnight from 15 days to 2 months of age and at monthly interval from 3 months to 6 months of age. Radiographs of cranio-caudal and medio-lateral views of right forelimb were taken into consideration. The radiographs were read for noting the number and time of appearance of ossification centers and time of closure of epiphysis.

Scapula

Scapula was developed from 2 centers, 1 for the body and other for the tuber scapulae. Center for the body was seen in recognizable shape in radiograph of 15 day (Fig. 2) old puppies, while the center for tuber scapulae (Fig. 1) appeared at 55 ± 3.17 days; 60 days and 52.5 ± 3.36 days in German shepherd, Pomeranian and non-descript respectively.

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The center for the tuber scapulae could be seen on medio-lateral view. Initially, it was rounded spot and with the advancement of age, it became wedge shaped. It remained separated from the body of scapula up to the age 180 days in all the 18 puppies except for the two Pomeranian puppies where the union was complete.

Humerus

Humerus developed from 5 ossification centers in all the puppies. The center for the diaphysis was seen in well-developed form at the age of 15 days with slight convexity at proximal as well as distal ends. The center for the proximal epiphysis appeared at 15 days age (Fig. 2), which became ellipsoidal with advancement of ossification to cap the globe like proximal end of the diaphysis. The union of proximal epiphysis with that of proximal end of diaphysis started at 180 days of age.

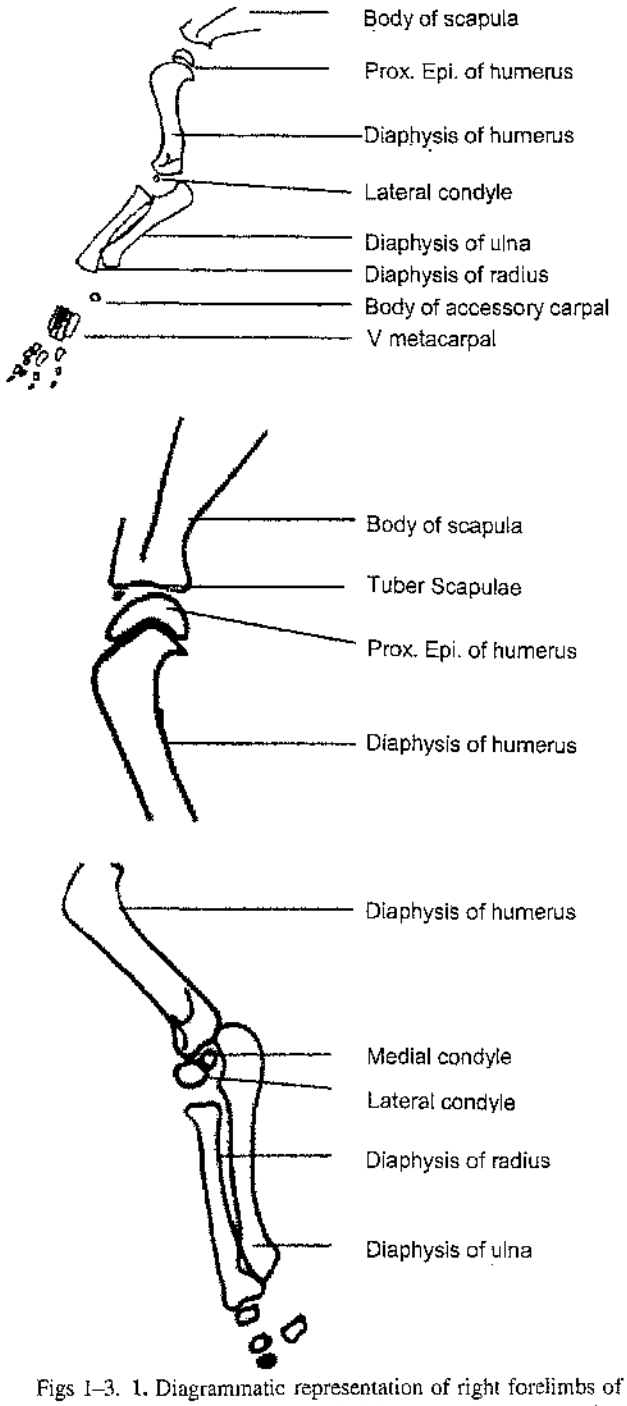
The center for the lateral condyle appeared at 15 days of age (Fig. 2) while, the center for medial condyle appeared at 30 days in all the 3 breeds of dog under study. However, the appearance of center for medial epicondyle (Fig. 3) showed variations amongst the breed (45 days in German shepherd, 47.5 ± 2.50 days in Pomeranian and 50 ± 3.17 days in non-descript).

At the age of 180 days, lateral and medial condyles were united with each other, while the medial epicondyle remained ununited with the diaphysis and condyles.

Radius

Radius was developed from 3 centers. The center for diaphysis was seen in well-developed form at the age of 15 days in all the breeds of dog. The center for the proximal epiphysis appeared at 30 days in German Shepherd and non-descript and 35 ± 3.17 days in Pomeranian. The center for distal epiphysis appeared at 22.5 ± 3.36 days in German Shepherd, 17.5±2.50 days in Pomeranian and 25±3.17 days in non-descript (Fig.4).

Initially, the center for proximal epiphysis was rounded and then, it took the disk like shape over the proximal end of the diaphysis. The centre for distal epiphysis became



Figs 1–3. 1. Diagrammatic representation of right forelimbs of 15-day-old male German Shepherd. 2. Diagrammatic representation of right forelimb of 60-day-old female non-descript. 3. Digrammatic representation of right forelimb of 30-day-old male German Shepherd.

rectangular in shape with the advancement in age. Both the proximal and distal epiphyses remained separated from diaphysis up to the age of 180 days.

Ulna

It was observed that the ulna was developed from 3 ossification centres, 1 each for the diaphysis, proximal epiphysis and distal epiphysis.

The diaphyseal centre was present in well-developed form with the proximal end being the larger at 15 days of age (Fig. 2). Along with the development, it showed concavity of the semilunar notch. The centre for the proximal epiphysis appeared at the age of 55 ± 3.17 days, 62.5 ± 6.02 days and 57.5 ± 2.50 days in German Shepherd, Pomeranian and non-descript puppies respectively. The centre for distal epiphysis appeared at 42.5 ± 2.50 days in German Shepherd and non-descript and 55 ± 3.17 days in Pomeranian (Fig. 5).

Proximal epiphyseal center was initially oval in shape, which subsequently became triangular. The distal epiphyseal centre took cone shape with the diaphyseal surface hollowed out to receive the distal end of the diaphysis. Both the proximal as well as distal epiphyses remained ununited up to the age of 180 days.

Carpus

Carpal bones were noted to develop from 10 centers one each for the ulnar carpal, first carpal, second carpal, third carpal and fourth carpal bone. The radial carpal bone of the proximal row developed from the fusion of ossification centers of 3 carpal bones, i. e. radial, intermediate and central. The accessory carpal bone developed from 2 centres, 1 for the body and other for the epiphysis.

The centre for the body of accessory carpal bone was the first to appear (Fig. 2), while the centre for epiphysis of accessory carpal bone was last to appear in carpus region.

Complete union of epiphysis and body of accessory carpal bone was observed at the 180 days of age in all the 3 breeds of dog.

Metacarpals

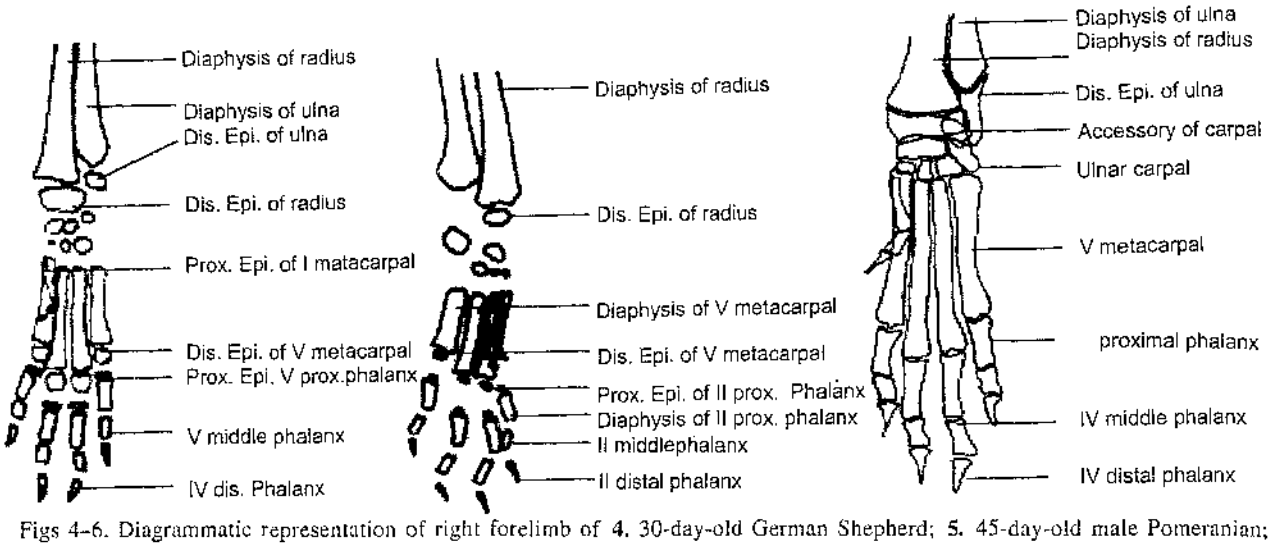
Each metacarpal developed from 2 centres, 1 for the diaphysis and other one was for the proximal epiphysis of first metacarpal and distal epiphysis of second to fifth metacarpal bones.

The centre for all the diaphysis was present in well-developed form at the age of 15 days in almost all the breeds of dog. The center for the proximal epiphysis of first metacarpal appeared at the age of 45 days in German Shepherd, 40 ± 3.17 days in Pomeranian and 42.5 ± 2.50 days in non-descript. The centre for distal epiphyses of second to fifth metacarpal appeared at 30 days of age in all the 18 puppies (Fig. 5).

The fusion of all the epiphyses with the respective diaphyses of metacarpal was completed at the age of 180 days in all the puppies of 3 breeds (Fig. 6).

Phalanges

Each digit consisted of 3 phalanges except for the first digit, where, it consisted of only 2 phalanges. The proximal and middle phalanges were developed from 2 centres of ossification, one each for the diaphysis and proximal



Figs 4–6. Diagrammatic representation of right forelimb of **4.** 30-day-old German Shepherd; **5.** 45-day-old male Pomeranian; **6.** 180-day-old female German Shephered.

epiphysis, while the distal phalanges were developed from only one centre, which was present at the time of birth.

The centre for the diaphysis of proximal and middle phalanges was present at the time of birth. The center for the proximal epiphysis of the proximal phalanx of the first digit appeared at the age of 45 days in German Shepherd, Pomeranian and non-descript puppies (Fig. 5). The centre for the proximal phalanges of second, third, fourth and fifth digits appeared at 30 days in German Shepherd and Pomeranian, while in non-descript at 37.5 ± 3.36 days. The closures of proximal epiphyseal plates of proximal phalanges were completed at 180 days.

The centre for the proximal epiphyses of middle phalanges of second, third, fourth and fifth digits appeared at the age of 45 days in German Shepherd and non-descript, while in Pomeranian, appeared at 30 days of age. The closure of proximal epiphyseal plates of middle phalanx of second, third, fourth and fifth digit was completed at 180 days in all the 18 puppies of 3 breeds.

SUMMARY

Age period for the appearance of the ossification centres that appear after birth in the limb bones of the dog were determined by radiography, at set intervals in 3 German Shepherd, Pomeranian and Non-descript. The ossification centres appeared in the same chronological order, but the ages at which they appear, showed variation.

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