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Soft Tissue Studies In Small Animal Radiography

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Radiologic investigations of normal and abnormal structures and conditions found in the skeletal system have yielded valuable information to the veterinary profession. The relatively great densities demonstrated by skeletal tissues and the alterations in those densities brought about by disease processes have aided in interpretation of abnormalities. They were readily observable on the film, and the techniques for producing diagnostic films, although rigid, were relatively easy of achievement. Recently, in both human and veterinary radiology, efforts at achieving the same wide use of the science of radiology have been pointed toward demonstration and interpretation of lesions which occur in the non-osseous portions of the body.

Techniques

It was quickly determined that demonstration of lesions in soft tissues required a sharpening of radiologic technique because of the decrease in density differences exhibited by soft tissues. This decrease in density differences of tissues resulted in a decrease in densities demonstrated on film and required techniques which more accurately reproduced them. An example of this is given in a film which was taken in an endeavor to demonstrate a known deficiency in cartilage which was present in the central portion of volar surface of a distal sesamoid removed from a bay gelding (Fig. 1). Exposures taken at two milliamper second (MaS) values and at varying kilovolts peak (KVP) were made. Fourteen exposures were made at two KVP intervals with only one exposure showing the deficiency as an area of decreased density. This was the exposure at ten MaS and 42 KVP. This will not be visible in reproduction as it was barely discernible in original. This series is included to demonstrate the difficulty of presenting soft tissue lesions in close association with the skeletal structures and also to illustrate that small differences in KVP will make important differences in interpretation where soft tissue lesions are concerned. Fortunately soft tissue studies are not limited to structures in which their mass is overshadowed by the mass of skeletal structure.

Exposures for soft tissue study can follow one of two techniques. One of these is a low KVP technique where MaS values are used to build up film density, and the other is high KVP technique where the MaS value is held low to prevent blackening of the film. The high KVP method results in films with less contrast and finer gradation in interpretation of relative densities. Both of these methods work satisfactorily when used effectively, and the choice of method will lie with the operator and his available equipment.
Fig. 1. Distal sesamoid of equine with proven cartilage deficiency.

Reading the pamphlet, "The Fundamentals of Radiography," which is obtainable from most local radiologic supply houses, will enable one to make a more effective choice. With most present day units, the low KVP technique with increase of MaS values to produce film darkening will be most satisfactory. With this method, the KVP value is used which produces radiation of wave length just sufficient to penetrate the tissues involved. Greater values produce secondary radiation, which will cause increased fogging of film and loss of value for interpretation.

Reduction of KVP values using the low KVP technique for soft tissue, as in Figure 2, shows that with small masses, such as those involved in canine limbs, this approach is more satisfactory. These films are all taken of a Great Dane with extensive cellulitis, several healed and currently draining fistulous tracts and destruction of the first articulation of the fifth phalanx. Lipiodol was injected into the medial fistulous tract to outline its extent. There is also shown some elevation of periosteum probably associated with the extensive cellulitis in this region.

**Interpretation and Selected Studies**

Interpretation of the soft tissue film requires knowledge of topographic anatomy and the ability to interpret the shadows produced by structures in three dimensions as they are presented in the single film plane. This can often lead to difficulties in the interpretation of both normal and abnormal structures. There should be no hesitancy to review the anatomy of the area involved, and this review should be from the topographic viewpoint. Dissection guides are of little use in this review. A descriptive approach is required to refresh the memory as to just where the structures lie.

The effect of soft tissue alterations on the skeletal system is often of value in their interpretation. This fact may be
demonstrated by normal and abnormal films showing the appearance of a chondrosarcoma of the nasal mucosa (Figs. 3 and 4). In the normal film, the trabeculations and bony formations of the turbinates are readily visible. In the film representing a chondrosarcoma, the normal structure of the turbinates is replaced by a mass of tissue which is obstructing the respiratory passageway. In this particular case, there was a minimum of deformation of the facial bones, and the lesion was difficult to demonstrate without the use of radiograph.

The skull cavity is another example of osseous structures which aid in the interpretation of soft tissue lesions. In cases of long standing increased intracranial pressure, there is an appearance of thin inner tables and prominent skull markings of the parietal and frontal bones. This is demonstrated in the case of osteogenesis imperfecta tarda which is shown in Figure 5. The channels of the emissary veins are also more readily visible in this instance. From this case it can be noted that observation of skeletal changes offers valuable information as to changes in the soft tissues with which they are closely associated.

Subdural hematocysts which form occasionally from traumatic origin are visible as areas of decreased density in the cranial cavity. A decreased density associated with the channels of the emissary veins and lateral sinuses occasionally accompanies encephalitis in the canine (Fig. 6).

The thoracic cavity contains large amounts of air in the air spaces of the respiratory system. This air serves as a naturally occurring radio-transparent substance. The respiratory system and the blood vascular system included in the thoracic cavity are, for this reason, very susceptible of radiologic study, and these studies give much valuable information. This has been reported in many countries by workers who have investigated the use of radiographs in pneumonic disturbances and in neoplastic metastasis.

One study of value is that of the heart itself. Figure 7 shows a normal size heart in an 11 year old dog. The next figure (Fig. 8) shows an enlarged heart in an aged dog. Occasionally an enlarged heart is found in which all four chambers are

Fig. 3. Normal skull, dorso-ventral view.

Fig. 4. Nasal chondrosarcoma, dorso-ventral view.
Fig. 5. Prominent skull markings and thin tables of osteogenesis imperfecta.

Fig. 6. Demonstration of emissary vein.
Fig. 7. Normal size heart in an 11 year old dog.

Fig. 8. Enlarged heart in an aged dog.
Fig. 9. Elevation of one side of diaphragm.

Fig. 10. Multiloculated cyst not involving the bladder.
dilated. In a young dog, these could have arisen from a congenital anomaly. This type of examination is of value in supplementing the regular physical examination, and the two must be given together to obtain the most value from each. Films of this kind are also of use in stimulating veterinary students to examine the extent of enlargement in cases which are presented for study.

Study of the diaphragm and of its movements is of great value in determining the status of the thorax and contents as well as, in some instances, the conditions which might be present in the abdominal cavity. References covering the diagnosis of diaphragmatic hernia may be found in the literature. In this type of hernia, a paradoxical movement of the diaphragm will often be observed under the fluoroscope. This is a movement just the opposite of that which might be expected. The crura elevate on inspiration and have a caudal movement on expiration. An example of a different type of lesion is shown in Figure 9 which demonstrates the elevation of one crura without a consequent elevation of the other. This sometimes occurs as a result of fibrosis in the lung. In this instance, elevation was accompanying a traumatic injury over the area of attachment of the crura.

The genito-urinary system is one which can quite readily be studied by means of soft tissue techniques. This was demonstrated in one case presenting nephritis. The kidney, pelvis, and ureters were shown to contain large numbers of renoliths. The left kidney was approximately normal in size, and the right kidney was enlarged. This represented an advanced instance of nephritis but did show that the kidney is readily demonstrable. Figure 10 represents a large cyst which is probably prostatic in nature. A question arose as to whether this cyst was in the bladder or not. The catheter in the bladder and injection of ten percent sodium iodide demonstrated that this cyst did not involve the urinary bladder. The cyst was continued in the pelvic cavity and passed through the region of the prostate, which also contained some smaller calcium deposits.

![Fig. 11. Arthritis and synovitis.](image)

A soft tissue study which also yields valuable information is that of the ligaments and tendons around the joints. This may be of value in traumatic lesions and also in chronic conditions which are producing lameness. Figure 11 shows one of these latter conditions. There is a generalized arthritis involving the ligaments of the joint and the joint capsule. There is also evidence on the dorsal surface of the tibia of slight calcification of the tibio-patellar joint capsule. This condition is often present alone and causes lameness of an obscure nature. In this case, there was also an indication of former stress of the medial collateral ligament with deposition of calcified deposits along its path and at its distal insertion. This was shown on the plantar dorsal view. The comma-shaped thick calcification present on the volar proximal aspect of the tibia was located in a sagittal plane just medial to the central axis. This was interpreted as a calcification of the joint capsule diverticulum. Use of a variable intensity light is of value in the study of joints and tendons.
Conclusion

Soft tissue studies in radiology are fully as rewarding as those of skeletal structures. They require attention to detail in exposure which exceeds that necessary for gross studies of osseous structures. Interpretation of them requires knowledge of topographic anatomy and pathologic processes which can involve the area examined. Displacement of normal structures and alterations produced in adjacent tissues are of value in determining the abnormalities present. The presence of calcification in soft tissues is often of value in determining location of lesions. Edema of tissues is demonstrable and also helpful in location.

The use of fluoroscopy and radiopaque media is of great value in the study of soft tissue structures. This discussion, however, has been purposely designed to show what can be accomplished with film work. The results of soft tissue studies encourage expenditure of the extra effort required to obtain diagnostic films.

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