SYNOVIAL FLUID ANALYSIS USED AS AN ADJUNCT TO DIAGNOSIS OF CANINE JOINT DISEASES

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ABSTRACT

SYNOVIAL FLUID ANALYSIS USED AS AN ADJUNCT TO DIAGNOSIS OF CANINE JOINT DISEASES

by Donald C. Sawyer

This project was undertaken to investigate the merits of synovial fluid examination as a diagnostic and prognostic aid in joint diseases of the canine.

This study was restricted to those practical tests which could be performed by a veterinary practitioner. Synovial fluid analyses included the following: total leukocyte and erythrocyte cell counts, differential cell count, pH measurement, mucin clot, viscosity, and bacteriological tests. The results of this study were presented in tabular form.

Using synovial fluid analysis, it is possible to determine the presence or absence of arthritis. It is also possible to differentiate arthritides of traumatic etiology from those of infectious etiology. In some cases, a differentiation may be made between acute and chronic joint diseases.

From the results of this study, it was concluded that synovial fluid analysis is a useful adjunct to the diagnosis of canine joint diseases.

Dedicated to

Judy

SYNOVIAL FLUID ANALYSIS USED AS AN ADJUNCT TO DIAGNOSIS OF CANINE JOINT DISEASES

By

Donald C. Sawyer

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INTRODUCTION

Synovial fluid analyses have been found to be useful in human medicine in the study of the arthritides.

In surveying veterinary literature, reference to similar analyses, from the standpoint of clinical usage, is non-existent in canine medicine.

This project was undertaken to investigate the merits of synovial fluid examination as a diagnostic and prognostic aid in joint diseases of the canine. This study was restricted to those practical tests which could be performed by a veterinary practitioner.

It was necessary to establish normal values for the six most common clinically affected articulations. Synovial fluid samples were taken from diseased joints, analyzed, and then compared to the normal values.

REVIEW OF THE LITERATURE

Diarthrodial articulations are characterized by a joint cavity, a synovial membrane in the joint capsule and by their mobility.[24] The articular or joint cavity is enclosed by the synovial membrane and the articular cartilages. Normally, it contains only sufficient synovial fluid to lubricate the joint. The joint capsules are membranous tubes or sleeves which enclose articular surfaces, epiphyses and in a few instances metaphases.[17] The capsule is divided into a fibrous layer (stratum fibrosum) and a synovial layer (stratum synoviale).[17,24] The mobility of the articulations are described by Sisson.[24] The gross and histological characteristics of the coxofemoral and stifle joints in the canine were described by Adam.[1]

The synovial membrane lines the joint but does not cover the hyaline articular surfaces.[17] The stratum synoviale is classified according to the character of the tissue beneath the lining cells into three types: fibrous, adipose, and areolar.[1,15,22] This highly vascular synovial tissue lining the inner surface of the articular capsule is not actually a membrane. It is a connective tissue with a modified inner surface.[9,17,22]

The articular cartilage, usually hyaline in type,[24] is avascular.[5,9,12] Its nourishment is derived from synovial

fluid except for a small supply from the subchondrium.[12]

Synovial fluid was so-named by Paracelsus because of its resemblance to egg white.[23] Sisson stated that "the synovial membrane secretes a fluid, the synovia, which lubricates the joint."[24] However, he questioned whether it is a true secretion or a transudate containing products of friction. Ropes and Bauer have defined synovial fluid as a protein containing dialysate of blood plasma to which mucin, secreted by the synovial cell, is added as the plasma water diffuses through the synovial tissue spaces into the large tissue space, the joint cavity.[22] Coggeshall stated that the constituents and antibodies of synovial fluid are essentially the same as those in blood plasma, but that the protein content of synovia was higher because it contained mucin and the products of normal friction.[12]

Synovial mucin is the polysaccharide component of bovine synovial fluid.[19] The hypothesis is advanced that this hyaluronic acid of the mesenchymal tissues is produced by mast cells in the bovine.[3] Mucin is mainly responsible for the viscosity of synovial fluid. The viscosity of human synovial fluid is that of water following precipitation of mucin with acetic acid.[22] Gardner stated that there is little doubt that the synovial cells are responsible for the presence of mucin in synovial fluid.[9] The mode of destruction of mucin is unknown but it is more than likely that it occurs in the fluid or tissues.[22]

The functions of synovial fluid are many. The

mucin content gives the fluid its lubricating properties. Frost indicated that there are two types of lubrication: boundary layer lubrication and hydrodynamic lubrication.[7] He stated that in the normal human joints moving slowly and intermittently under load, boundary conditions exist. Crepitus may be noticed when a joint is manually moved without bearing weight. In joints moving rapidly, hydrodynamic conditions exist and wear is reduced to an insignificant level by a film of synovial fluid forced between the moving joint surfaces. In accordance with this theory, a wedge-shaped film of lubricant is formed and movement of the two bearing surfaces is in the direction of the narrow end of the wedge; the circulating fluid enters at the base and leaves at the narrow apex.[9] It has been shown that a 50 micron film is effective in lubrication of the human knee.[18] It also has been demonstrated that the coefficient of friction in a dry joint is 14 times greater than that in a joint kept lubricated by synovial fluid.[12]

In the stifle joint, the menisci automatically set themselves at the tilt which ensures the formation of the fluid wedge.[9]

Besides its lubricating properties, the high base-binding property of mucin aids in the calcium equilibrium of the joint fluid. It is also important in the transfer and maintenance of the volume of plasma water in the joint.[22]

The plasma portion of synovial fluid serves as the main source of nutrients to the articular cartilage.[2] The

metabolic rate of the hyaline cartilage is one-tenth that of connective tissue because there is a large amount of matrix.[12]

When the joint is in motion, the elastic action of the articular cartilage squeezes out and reabsorbs fluid, as a sponge.[2] This is important in the nutrition of the cartilage as well as in the dissipation of the heat produced by normal friction.[7]

The pH of the stifle joint fluid of dogs has been determined under various physiological conditions and after intravenous injection of electrolytes.[14] Parallel determinations of blood pH have also been carried out. The average pH of one control stifle was 7.30 taken during the resting state. The measurements were made with a needle in combination with a capillary glass electrode.

The removal of particulate matter and cellular debris from normal wear of the joint tissues is achieved primarily by the mononuclear phagocytes in the synovial fluid.[12,18,22,25] The cytology of synovial fluid in normal joints of rabbits was reviewed by Key in 1928.[15] He stated that normal joint fluid contains living cells in numbers varying from 100 to 300/mm.[3] He used supravital stains and classified the cells as follows:

Cell	Range (%)	Average (%)
Monocyte	42-84	58
Indeterminate macrophages	3-29	14
Primitive cells	0-10	1

Cell	Range (%)	Average (%)
Polymorphonuclear cells	0-12	5
Synovial cells	0-7	3

These results were obtained from synovial fluid of 50 shoulder joints of the rabbit. According to Key, degenerating cells and cartilage cells were practically never seen.[15] Contrary to this, Warren, et al. indicated that degenerating cells are frequently encountered in normal bovine synovial fluid.[25] They are distinguished from normal living cells by their failure to react to vital dye, by their hyaline nuclei which are stained pale green, and by their shrunken or excessively vacuolated cytoplasm.

Simultaneous studies of canine synovial fluid and blood indicated that the cytology of synovial fluid is not influenced by the blood cytology, i.e., the polymorphonuclear leukocytes of the blood in one animal averaged 66%, yet the synovial fluid contained none. The results of these cytological studies conducted on the stifle joints of 14 normal dogs are as follows:[25]

Nucleated cells --- 327 - 1450/mm^3 (average 963.8/mm^3)

Erythrocytes ------ 0

Phagocytic cells

Polymorphonuclear leukocytes -------- 0 - 7% (average 1.7%)

Monocyte ---------- 56 - 90% (average 68.5%)

Clasmatocyte ------- 0 - 20% (average 6.5%)

Unclassified cells - 0 - 4% (average 3.4%)

Non-phagocytic cells

Lymphocytes -------- 2 - 36% (average 15.7%)

Synovial cells ----- 1 - 9% (average 4.8%)

A difference in the phagocytic cell content of the carpometacarpal and astragalotibial joint fluids has been reported.[25] This difference represents the response necessary for the removal of friction debris as a result of the comparative differences of joint trauma.

Bauer, et al. indicated that nucleated cells found in synovial fluid in normal cattle are similar in number and types to those described previously in normal rabbits.[18] Furthermore, he reported that 90-95% of all nucleated cells present are actively phagocytic. This implies that the function of these cells is the removal of tissue debris in the articulation.

Studies of the cell content in cattle, sheep, and horses reveals that the content of nucleated cells varies considerably from joint to joint in the same animal, e.g., in cattle from about 200/mm^3 in the appendicular joints to about 1200/mm^3 in some of the axial joints.[6] Davies found that of the cell types, monocytes form about 50% of the total, accompanied by fewer clasmatocytes.[6] The remainder were lymphocytes, polymorphonuclear leukocytes, synovial cells, and unclassified phagocytes. He showed a significant variation in the proportions of these different types from joint to joint and from species to species.

Key contended that red blood cells are normally

found in joint fluid.[15] However, Davies stated that red blood cells do not normally occur in synovial fluid, though small traumatic extravasations from the delicate capillaries are frequent.[6] Further, red blood corpuscles seem to be present in numbers directly proportional to the trauma to which the synovial membrane is subjected.[18]

Accurate differentiation of mononucleated cells can only be made from supravitally stained preparations. It is not necessary to differentiate the various types of mononuclear cells as the most important diagnostic criterion is the percentage of polymorphonuclear cells. For this reason, the fixed smear method (Wright's stain) is practical for the usual clinical examination. Coggeshall stated that the polymorphonuclear cells should not exceed 25% of the synovial fluid leukocytes in normal human joint fluid.[12]

Kling has commented on staining methods of synovial fluid.[16] The drawbacks of supravital staining are that it requires special technical training, prolonged observation by the technician, immediate examination of the fluid, and poor visibility of nuclei. Also, the use of specific granulations is doubtful as a reliable criterion for identification of the cells. The advantages of routine blood stains (Wright's stain) are many. It is a technique with which every technician is familiar. It can be carried out at any time. It is observed and easily read. It gives a distinct picture of the nucleus with its chromatin and centrosome.

Ropes and Bauer have classified pathological fluids in the human into the following groups:[22]

Group I. Inflammatory reaction of traumatic origin

A. Traumatic arthritis

1. Injury to semilunar cartilage

2. Hemorrhagic effusions

B. Osteochondritis dissecans

C. Degenerative joint disease

D. Neuroarthopathy

E. Osteochondromatosis

Group II. Infectious arthritis of known origin, Reither's syndrome, and Rheumatoid arthritis.

The above authors explain that the cytology of the synovial fluid is related to the type, severity, and duration of pathology. It is possible to differentiate groups I and II by a total leukocyte count and an absolute polymorphonuclear cell count in almost all cases. Normal synovial fluid is sterile. Therefore, positive synovial fluid cultures are essential in order to prove a diagnosis of infectious arthritis. A positive culture is expected in fluid containing more than 30,000 synovial fluid leukocytes/mm.[3] Ropes, et al. have indicated that there is no definite correlation between the size of the effusion and the etiology, severity, or duration of the joint disease.[22] They found that as the inflammation in the joint subsided, the amount of fluid that could be aspirated decreased. They reiterated

that the relative proportion of polymorphonuclear and mononuclear cells gives the best indication of the degree and type of inflammation present. It is also important to determine the total number of phagocytes to ascertain the degree of tissue irritation and injury to the articulation.

The following results were collected on normal human synovial fluid from the stifle joints using supravital staining techniques for cellular classification:[22]

Analyses	Range	Average
Amount (cc)	0.13 - 3.5	1.10
pH	7.29 - 7.45	7.39
Leukocytes/mm^3	13 - 180	63
Differential counts in %		
Polymorphonuclear leukocytes	0 - 25	6.5
Lymphocytes	0 - 78	24.6
Monocytes	0 - 71	47.9
Clasmatocytes	0 - 26	10.1
Unclassified cells	0 - 21	4.9
Synovial cells	0 - 12	4.3

MATERIALS AND METHODS

Canine synovial fluid in most articulations is normally present in very small quantity. In order to minimize loss of fluid in the barrel of the syringe, a two cubic centimeter syringe was used for collection of fluid for analysis. Initially, the use of a one cubic centimeter syringe was attempted. However, the construction of this syringe does not allow sufficient negative pressure to aspirate fluid.

Eighteen, 20, and 22 gauge hypodermic needles are preferred, with a range in length from 1 inch to 2.5 inches. A regular point needle was used. The gauge and length of the needle used were governed by the size of the articulation, the thickness of the surrounding tissues, and the accessibility of the capsule. For routine use, a 1 inch, 20 gauge, disposable needle was satisfactory.

The needles and syringes were autoclaved at 250 F for 15 minutes.[21] The assorted needles were sterilized in reusable nylon Needletainers.* The syringes were sterilized in packets** for easy handling.

A form (table 1) was used to record the information obtained from the fluid analysis.

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*Sterilon Corporation, 500 Northland Ave., Buffalo, New York.

**OK Sterilization Bags. Propper Manufacturing Co., Inc., Long Island City, N.Y.

Table 1. Synovial Fluid Examination Form

Case No.*_____Date_____Clinic No._____

Breed_____Sex_____Age_____Restraint_____

Previous Examination: Yes____No____Date_____Case No._____

Articulation:_____Fluid collected by:_____

Remarks:

Amount:_____ml. Nature_____

Mucin clot: Normal____Fair____Poor____Very Poor____pH____

Viscosity: Normal_____Reduced_____Greatly Reduced_____

Leukocytes_____/cu. mm. (cells_____/ _____squares @ _____dilution)

Erythrocytes_____/cu. mm. (cells_____/ _____squares @ _____dilution)

Polymorphonuclear leukocytes_____% _____/ cu. mm.

Monocytes _____% _____/ cu. mm.

Clasmatocytes _____% _____/ cu. mm.

Lymphocytes _____% _____/ cu. mm.

Bacteriological exam:

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*Each synovial sample was given a case number. A copy of this report was filed with the animal's medical record, by clinic number.

The term, nature, as used on the record form, refers to some of the gross physical characteristics. Such descriptive terms as follow might appear: clear, slightly cloudy, cloudy, flocculent, and purulent. Terms used to describe color were: light yellow, yellow, sanguineous, and sanguineous due to technique.

A. Properties of joint fluid examined in a routine analysis.

1. Mucin

The quality of the mucin was measured by its degree of precipitation when mixed with acetic acid.[8] One to two drops of a non-oxalated sample of synovial fluid were added to an acetic acid solution prepared as follows:

a. One tenth of a milliliter of 7 N glacial acetic acid was added to 4 ml. of distilled water in a 10 ml. vial. For convenience, these vials can be frozen for storage and thawed before use.

b. The synovial fluid is added slowly to the acid, taking care that the sample does not contact the glass as it is added.

c. Allow to stand for 15 to 30 minutes.

d. Gently shake the solution.

e. Four grades of mucin clot are observed: (see figure 1)

(1) NORMAL--tight, ropy clump in a clear solution

(2) FAIR--soft mass in a slightly cloudy solution

(3) POOR--small, friable masses in a cloudy solution

(4) VERY POOR--few flecks in a cloudy solution

2. pH

The pH of the synovial fluid was measured using phenol red as an indicator. One drop of the synovial fluid was added to 1 ml. of phenol red indicator. The preparation of the indicator was as follows: 28.2 ml. of 0.01 N NaOH was added to 0.1 gram of phenol red. This was brought to a pH of 7 by diluting it with distilled water. The following table illustrates the procedure used to prepare the standard pH scale.

Table 2. Preparation of the Standard pH Scale

Volume of Na_2HPO_4* solution in ml.	Volume of KH_2PO_4** solution in ml.	pH of mixture
10.00	0.00	8.3
9.75	0.25	8.0
9.50	0.50	7.8
9.00	1.00	7.6
8.00	2.00	7.4
7.00	3.00	7.2
6.00	4.00	7.0
5.00	5.00	6.8
3.00	7.00	6.4

*11.867 grams of $Na_2HPO_4.2HOH$ were added to one liter of distilled water.[10]

**9.078 grams of KH_2PO_4 were added to one liter of distilled water.[10]

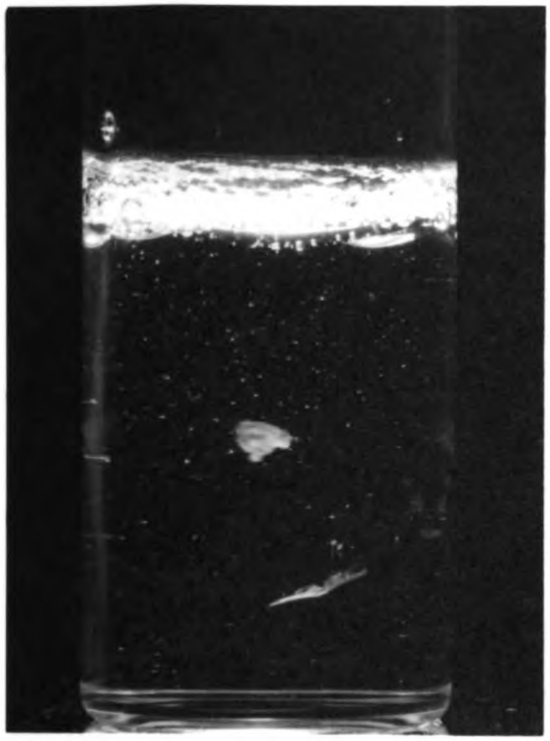
Figure 1. The four grades of mucin clot.

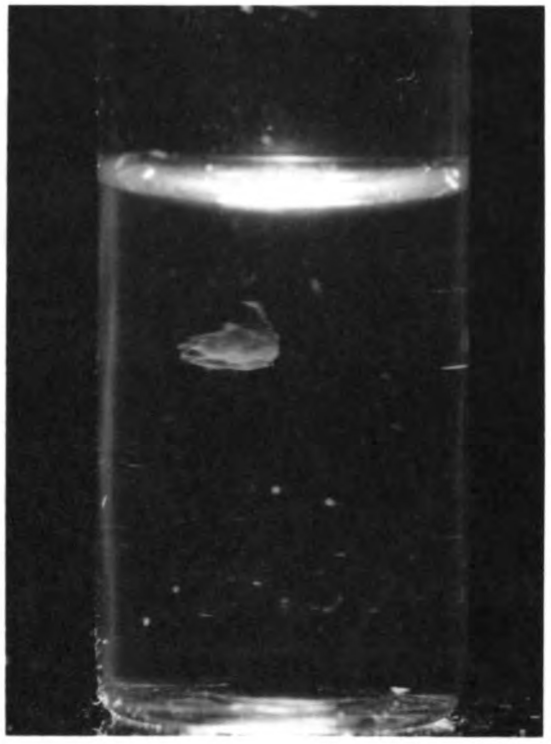
A. Upper left...Normal

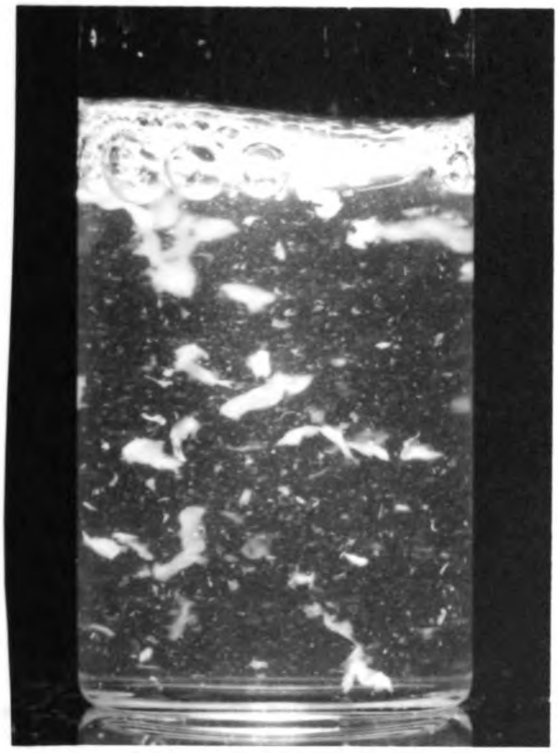
B. Upper right...Fair

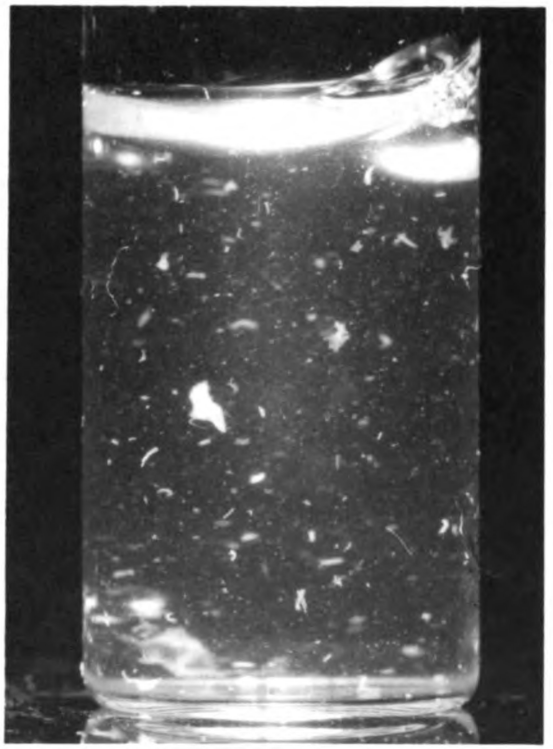
C. Lower left...Poor

D. Lower right...Very poor









One drop of each solution was then added to 1 ml. of the phenol red indicator to establish the standard pH color scale. The phenol red indicator with the synovial fluid added was then compared to the standard scale for pH measurement.

3. Viscosity

The viscosity of synovial fluid was measured by subjectively estimating it to be either normal, reduced, or greatly reduced. The limited volume of fluid which normally can be aspirated from canine articulations does not allow a practical method of viscosity measurement.

4. Cytology

All cellular studies were done using a Dialux or Labolux IIIa microscope.* The differential cell count was best done under the oil immersion objective.

The total leukocyte and erythrocyte count was made using a standard hemacytometer.** A standard WBC pipette was used for diluting the synovial fluid. When possible, a 1:10 dilution was made. However, a limited volume of the sample may necessitate a higher dilution. Cells in all 9 large squares were counted because of the small number

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*Ernest Leitz, Inc., New York, N.Y.

**Sharp Line Hemacytometer. Improved Neubauer Ruling, Chicago Apparatus Co., Chicago, Ill.

normally present. Since synovial fluid will clot when mixed with acetic acid, 0.85% NaCl solution (normal saline) was used as the diluting fluid instead of the customary white blood cell diluting fluid (2% acetic acid). Crystal violet was added to the saline solution to make a final concentration of 1% and then filtered. The crystal violet was added to stain the leukocytes, thus making them easier to count.

A synovial fluid smear was prepared by placing one to two drops of synovia between two 75 X 75 millimeter microscope slides. The slides were pressed together by circular sliding movements until the fluid was distributed evenly, and then separated by sliding one off of the other with a quick, snappy motion. The smears were air dried and stained with Wright's stain for a differential cell count. The stain was added to the slide and allowed to remain for ninety seconds. The buffer was then added and mixed with the stain by gently blowing on the slide. This staining procedure helps prevent over-staining to the cells. The stain should be filtered daily to minimize stain debris.

5. Bacteriology

Bacteriological examination was made on the synovial samples if there was sufficient volume to perform

all of the other tests. Following the initial tests, a sterile swab was used to absorb the remaining fluid in the barrel of the syringe. The swab was then plunged into 5 ml. of semi-solid brain-heart infusion agar and incubated for 10 to 14 days at 37 C. If there was no growth, the culture was discarded. If growth was noticed, further attempts for isolation of the organism were made. Bacteriology is not an essential part of the analysis in routine practice.

B. Procedures for arthrocentesis

To prepare the site for arthrocentesis, the following method was used. First, the hair on the skin was clipped at the site of the needle puncture. Second, this area was scrubbed 5 times with Liquid Germicidal Detergent.* The procedures for arthrocentesis of the six most common clinically affected joints in the canine have been adapted from the work of Hennau and Lassoie,[11] and from a booklet on injection techniques.[13]

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*Parke, Davis and Company, Detroit, Michigan.

Figure 2. The procedure for arthrocentesis of the carpal joint (radio-carpal, intercarpal, and carpo-metacarpal joint capsules)

The animal is positioned in lateral recumbency. The carpus is flexed to open the joint spaces. It is entered from the anterior surface. The tendons of the extensor muscles of the carpus pass over the anterior surface and must be penetrated before reaching one of the three joint capsules. The radio-carpal capsule surrounds the distal end of the radius and ulna and the proximal articular surfaces of the radial, ulnar, and accessory carpal bones. It is non-communicating and may be reached by directing the needle into the joint space between the radius and the radial carpal bone (A). The intercarpal capsule surrounds the distal articular surfaces of the radial and ulnar carpal bones and the proximal articular surfaces of carpal bones I, II, III, and IV.[20] The carpo-metacarpal joint capsule surrounds the distal articular surfaces of the metacarpal bones. The latter two capsules communicate with one another and may best be reached by entering the joint space between the radial carpal bone and carpal bones II and III (B). The proximal collateral radial artery, accessory cephalic vein, and superficial radial nerve must be avoided as they pass over the anterior surface of the carpus. The vein is easily identified in most cases.

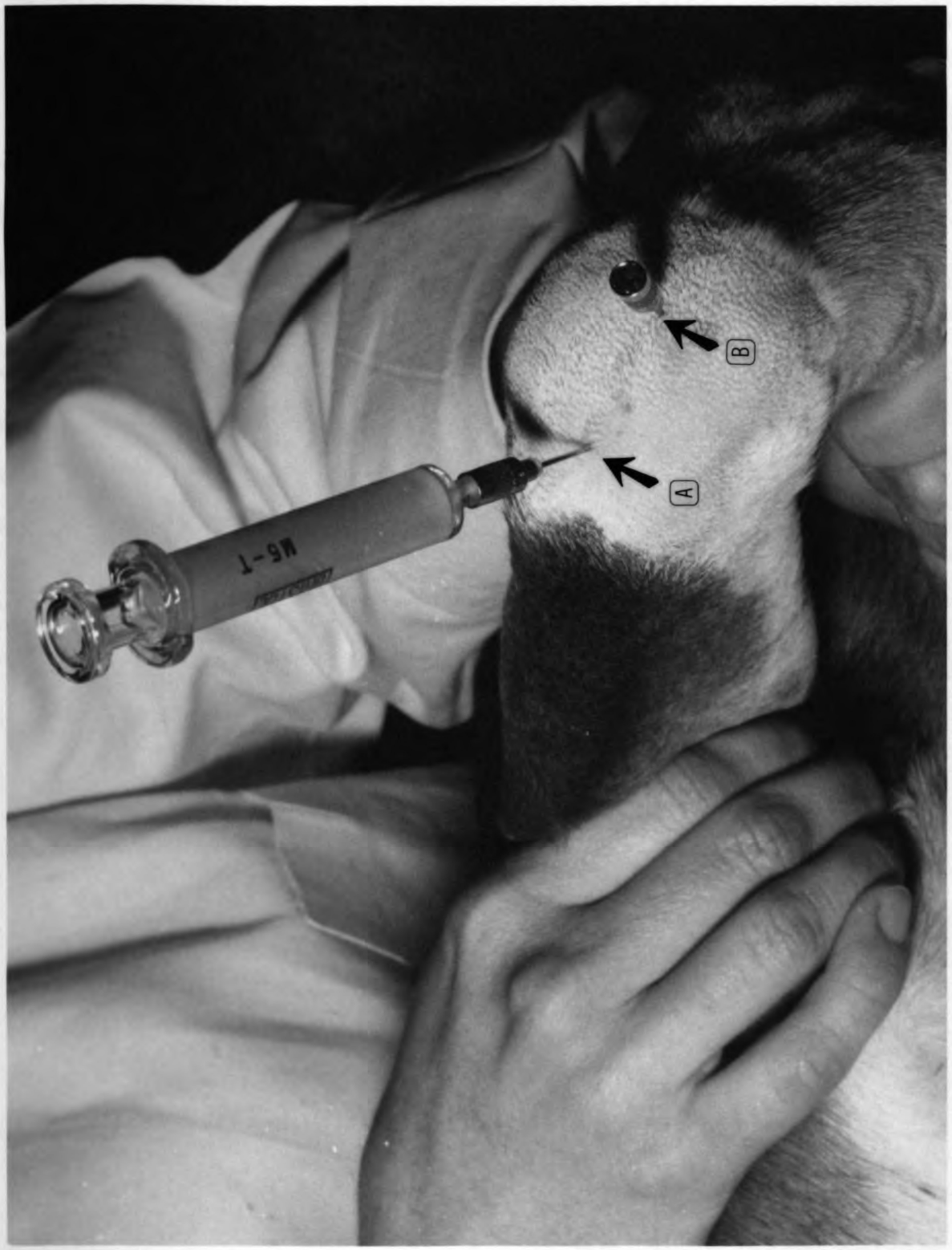
B
A

Figure 3. The procedure for arthrocentesis of the elbow joint (cubital joint capsule)

The animal is positioned in lateral recumbency. With the elbow joint in a slightly flexed position, the lateral condyle of the humerus (A) is palpated at its articulation with the semilunar notch of the ulna. The joint is approached from the postero-lateral surface of the forelimb. The needle is placed posterior and medial to the lateral condyle and slightly dorsal to the olecranon process (B). The anconeus muscle and the tendon of insertion of the triceps muscle group are penetrated before reaching the joint capsule. If the needle hits the bone it is partially retracted and redirected into the joint space.

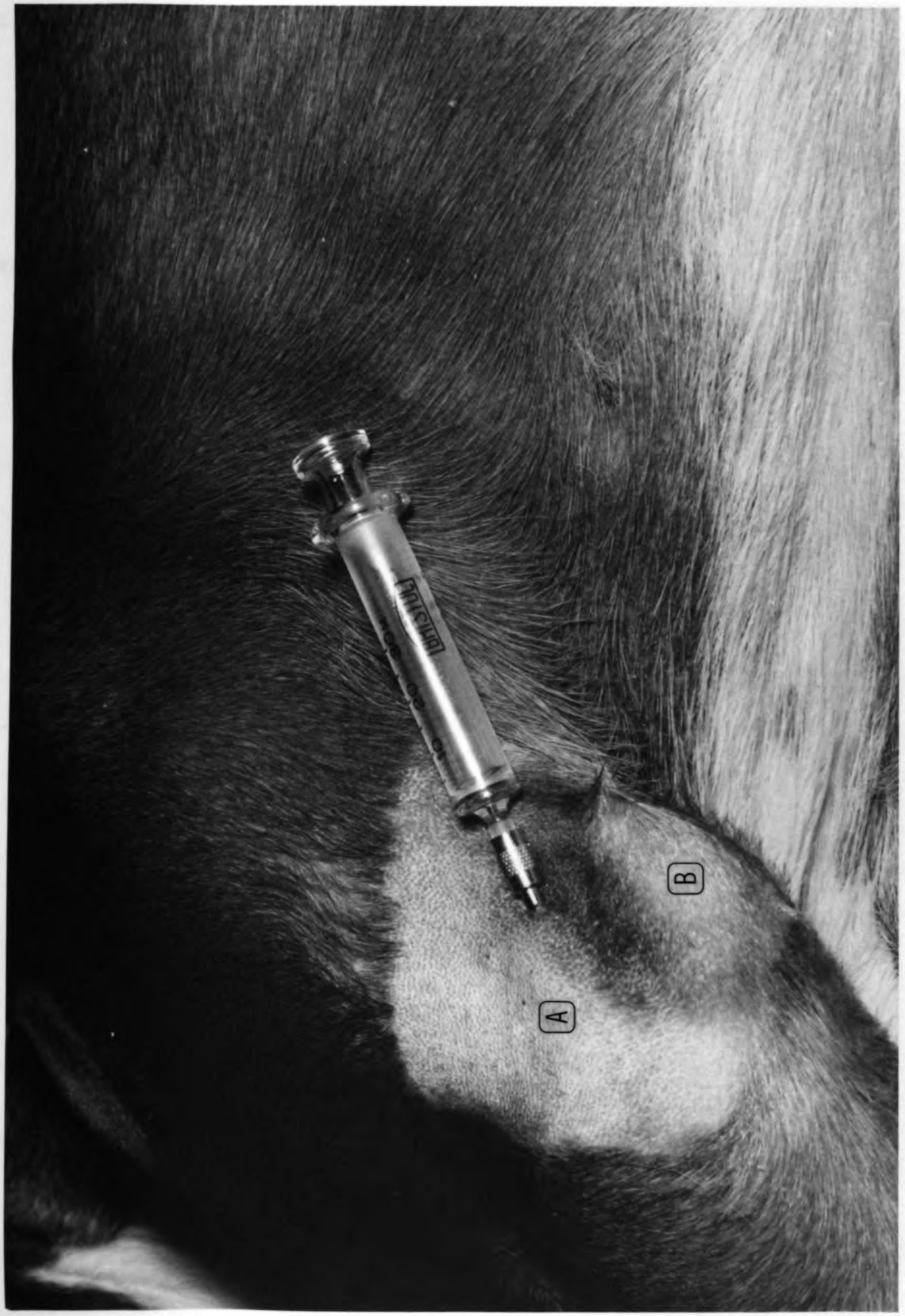
A
B

Figure 4. The procedure for arthrocentesis of the shoulder joint (scapulo-humeral joint capsule)

The animal is positioned in lateral recumbency. Arthrocentesis is best accomplished with the joint in a flexed position. Using the acromion process as a guide, the needle is placed ventral to it and directed obliquely downward and posteriorly through the biceps brachii and deltoideus muscles to the joint space.

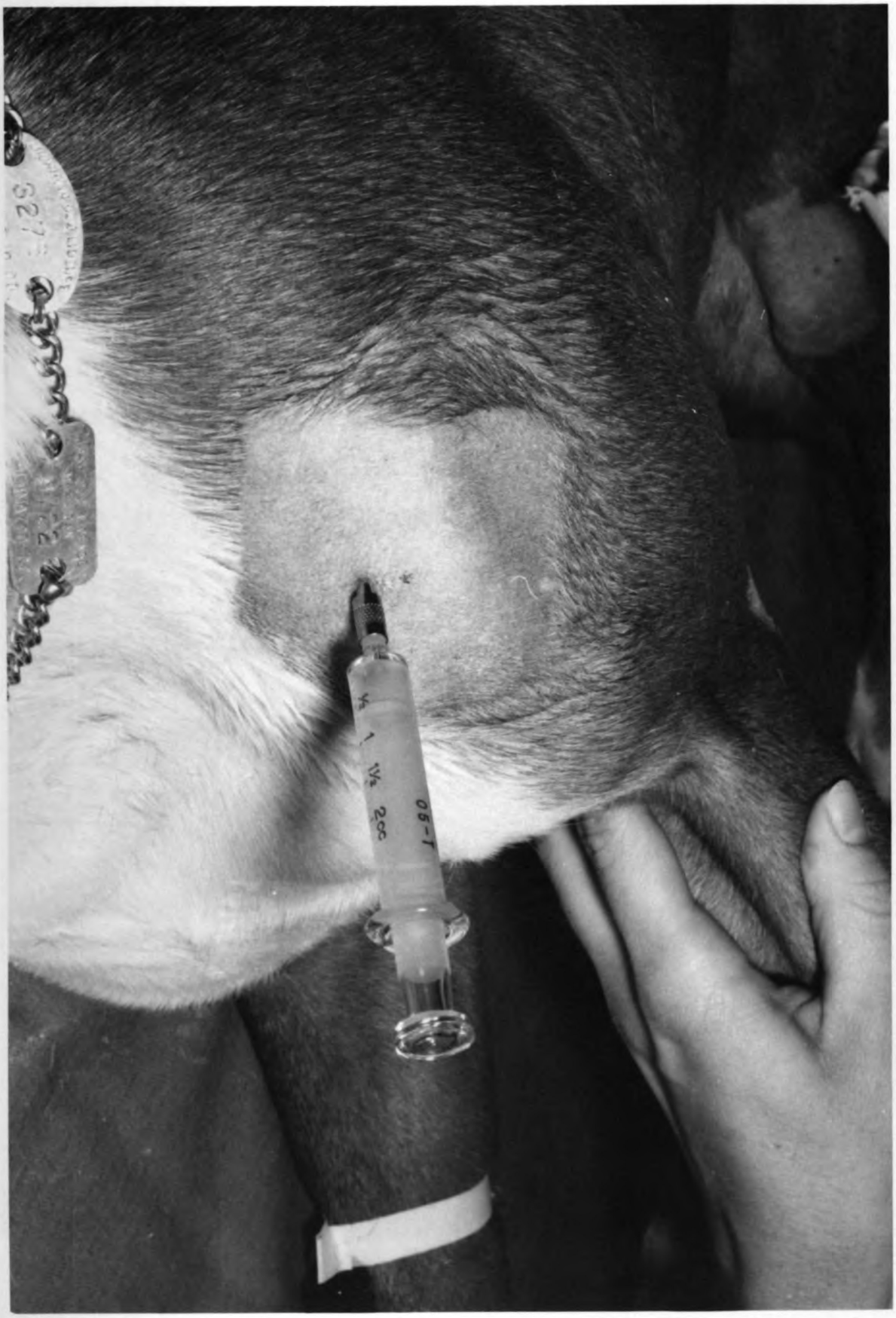
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Figure 5. The procedure for arthrocentesis of the hip joint (coxofemoral or coxal joint capsule)

The animal is positioned in lateral recumbency. The hind limb is allowed to rest in the normal standing position. Pulling the leg slightly upward and rotating the femoral head anteriorly facilitates arthrocentesis. The hip joint is covered on its dorsal surface by the large glutial muscles. The greater trochanter is palpated. The needle penetrates the skin at a point anterior to the greater trochanter and is directed postero-ventrally toward the joint space. If it contacts the femoral neck, head, or acetabular rim, redirect the needle until it penetrates the joint capsule and enters the joint space. The sciatic nerve must be avoided as it passes posterior to this articulation. One may occasionally lacerate the circumflex femoral artery which overlays the joint capsule and thus aspirate gross amounts of blood.


10
20
30

Figure 6. The procedure for arthrocentesis of the stifle joint (femoro-patellar and femoro-tibial joint capsules)

The animal is positioned in lateral recumbency. The stifle is flexed to tense the joint capsule. The leg is abducted to a vertical position. Arthrocentesis is accomplished from either side of the straight patellar ligament. By pressing downward on the tense capsule on the opposite side of the ligament, a bulge is produced. The skin is penetrated at this point and the needle is directed obliquely downward under the ligament into the synovial cavity. The two joint capsules communicate.

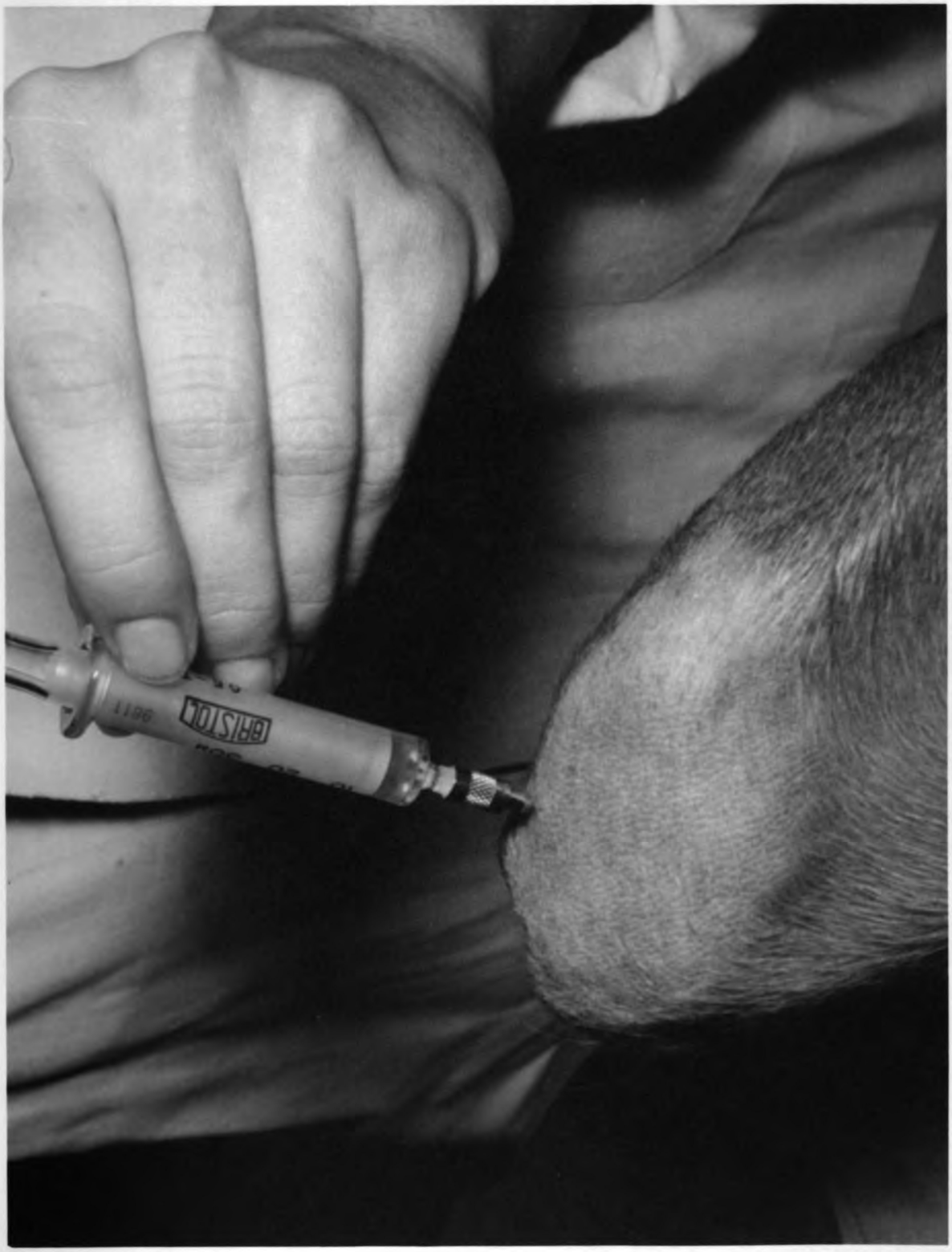
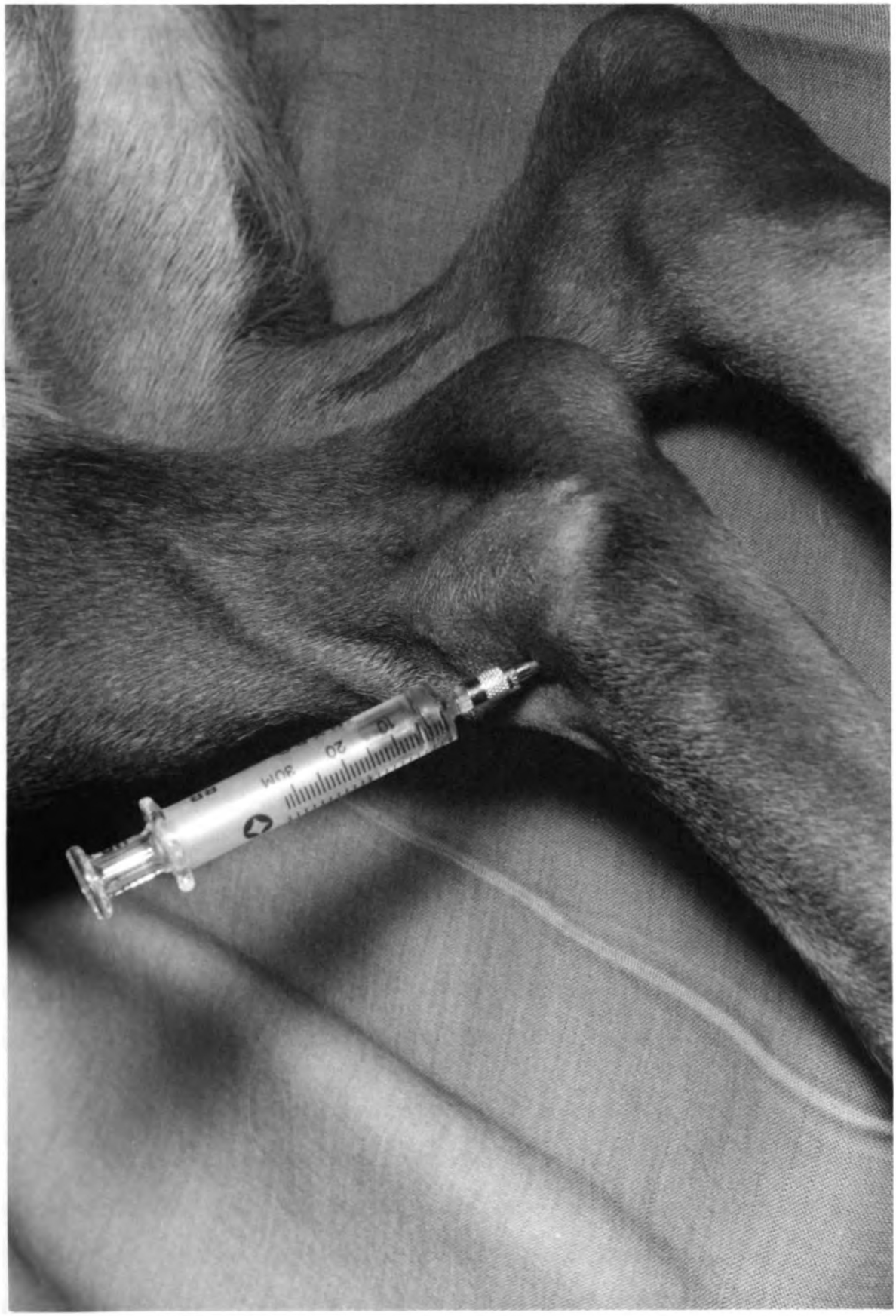

BRISTOL

Figure 7. The procedure for arthrocentesis of the hock joint (tibio-tarsal, intertarsal, and tarso-metatarsal joint capsules)

The animal is positioned in lateral recumbency. Arthrocentesis is best attained from the anterolateral or anteromedial aspect of the hock joint. By alternately flexing and extending the joint, the interspace between the tibia and tibial tarsal bone is palpated. The needle is inserted alongside of the flexor tendons of the hock and directed into the joint space.


10
20
30M

C. Environmental conditions for experimental dogs.

There were 105 animals used in this study. Forty-six of these were used to establish the normal values. These animals underwent physical examinations and were determined to be normal. The normal dogs were randomly selected from dogs purchased by the university to be used for other experimental purposes. In a few instances, fluid samples were taken from normal dogs prior to euthanasia requested by the owners.

Pathological synovial fluid samples were taken from arthritic dogs following their admittance to the veterinary clinic.

In most cases, a general anesthetic was necessary for sampling procedures. In a few instances, tranquilization with a local anesthetic was adequate for restraint.

RESULTS AND DISCUSSION

The results of this study are presented in tabular form. In order to minimize repetitive information in each table, a key which presents basic information about each animal has been used. This key is table 3.

The following example will help explain the recording procedure. In table 4, a mongrel (M), female (F), 5 years old, is designated animal number 18. In table 5, the number 18 appears at the top of the table. Reading across the page, it is noted that on 6-19-61, 0.10 cc of synovial fluid was aspirated from the left carpus (A). Initially the fluid obtained from the joint was clear (c) but toward the end of the sampling procedure, blood was introduced into the sample (t). The mucin clot was normal (N) and the viscosity was normal (N). The pH was 7.4. The leukocyte count was 400/mm^3 and the erythrocyte count was 66,400/mm^3. The differential cell count was presented as both per cent and absolute numbers for each cell type. This recording procedure is followed for each sample.

General Observations

Four nucleated cell types are seen in the canine joints (figure 8): polymorphonuclear leukocyte, monocyte, lymphocyte, and clasmatocyte. The eosinophil was not observed in joint fluid during this study. The synovial cell

was seldom seen and was not included in the differential cell count. Erythrocytes (figure 8) may or may not be found in normal joint fluid. Blood may be introduced into the joint fluid during the sampling procedure. Contamination of the sample with trace amounts of extraneous blood does not appear to interfere with the analysis of joint fluid. Experience has indicated that gross amounts of blood will interfere with joint fluid analysis.

The appearance and staining characteristics of the nucleated cells from normal joint fluid differ slightly from those seen in fluids obtained from pathological joints. The cytoplasm and the nucleus of cells from normal joint fluid do not appear as distinct as those from abnormal fluid. Some cells which have been smeared on a slide stain much darker than do others.

Degenerating nucleated cells were seen in fluids obtained from normal joints and pathological articulations. These cells could not be classified as a definite cell type. They were more commonly seen in normal joint fluid.

The amount of synovial fluid obtained from the normal articulations averaged 0.24 cc (table 12). Much less than this may be aspirated from either normal or pathological articulations. When a limited volume, i.e., 0.05 cc, does not allow for all of the laboratory tests, the differential cell count should be done first. With any remaining fluid, the total cell counts should be attempted and then the mucin clot test.

The characteristics of normal canine stifle joint fluid differ from those of normal human knee joint fluid which were stated previously. The leukocyte count of the canine samples ranged from 200 to 1180/mm^3 compared with a range of 13 to 180/mm^3 in the human. The pH of canine joint fluid averaged 7.58 $\pm$ .08 compared with 7.39 in the human. In general, the differential cell count of canine stifle joint fluid is similar to that found in human knee joint fluid.

Figure 8. Cell types observed in canine synovial fluid

A. Upper left...A monocyte (Wright's stain, X 3750)

B. Upper right...Two clasmatocytes (Wright's stain, X 3750)

C. Lower left...Two lymphocytes (Wright's stain, X 3750)

D. Lower right...Two polymorphonuclear leukocytes and an erythrocyte (arrow) (Wright's stain, X 3750)

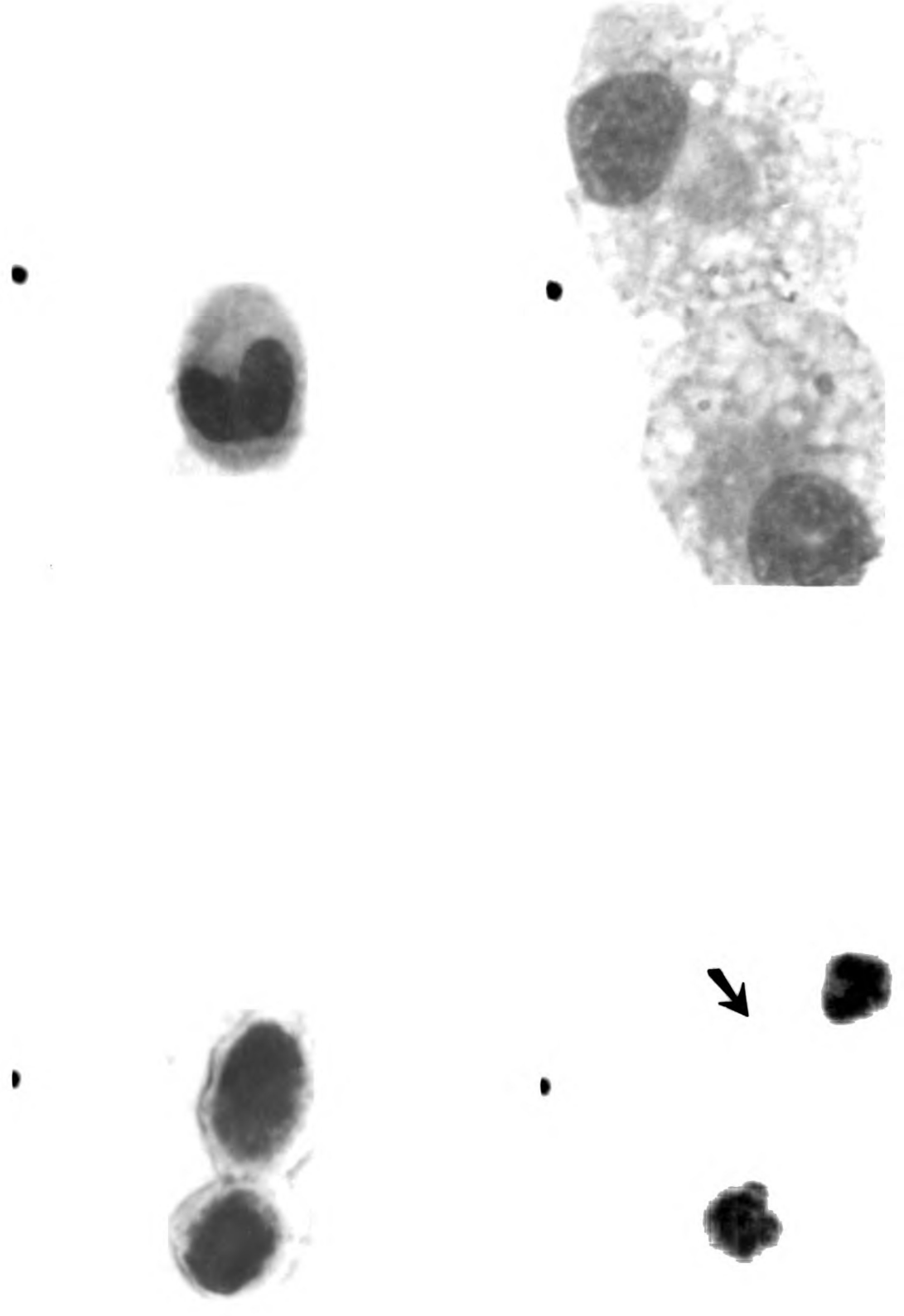


Table 3. Identification key for the breeds of the dogs, articulations, synovial fluid nature, mucin clot, and viscosity.

Breeds of dogs		Articulations:	left	right
B	- Boxer	Carpus	A	A'
Ba	- Basset hound	Elbow	B	B'
Be	- Beagle	Shoulder	C	C'
Bm	- Bull Mastiff	Hip	D	D'
Bt	- Boston Terrier	Stifle	E	E'
C	- Collie	Hock	F	F'
Cs	- Cocker Spaniel			
D	- Doberman Pinscher	Nature		
Da	- Dachshund	nature		
Eb	- English Bulldog	c - clear		
Ep	- English Pointer	s' - slightly cloudy		
Es	- English Setter	c' - cloudy		
Gd	- Great Dane	f - flocculent		
Gos	- Gordon Setter	p - purulent		
Gp	- German Short-hair Pointer			
Gs	- German Shepherd Dog	color		
Is	- Irish Setter	l - light yellow		
K	- Keeshond	y - yellow		
L	- Laborador Retriever	s - sanguineous		
M	- Mongrel	t - sanguineous due to technique		
Mp	- Miniature Poodle			
Ne	- Norwegian Elkhound			

Table 3. (Continued)

Breeds of dogs (continued)

S - Shetland Sheepdog

Sp - Standard Poodle

Ss - Springer Spaniel

Stb - St. Bernard

V - Vizsla

W - Weimaraner

Mucin clot

N - Normal

F - Fair

P - Poor

V - Very poor

Viscosity

N - Normal

R - Reduced

G - Greatly reduced

Table 4. (Continued)

Breed	Sex	Age	Animal Number
M	--	--	24
M	F	7 yr.	25
Ba	M	13 wk	26
Ba	M	13 wk	27
Sp	F	3 yr.	28
M	F	7 yr.	29
M	F	6 yr.	30
M	--	--	31
M	--	--	32
M	--	--	33
Gs	M	1½yr.	34
Gs	F	11 wk	35
Stb	M	7 mo.	36
M	M	2½yr.	37
Gs	M	5½yr.	38
Es	M	3 yr.	39
Mp	F	7 mo.	40
Mp	F	5½mo.	41
Bt	F	10 yr	42
K	F	4½yr.	43
Sp	F	3 yr.	44
M	F	4 yr.	45
M	M	4 yr.	46

Table 4. Animal identification key for Table 5

Breed	Sex	Age	Animal Number
Gs	F	4 mo.	1
Gs	F	4 mo.	2
Gs	F	4 mo.	3
M	F	5 yr.	4
M	F	7 yr.	5
B	M	1 yr.	6
M	F	2 yr.	7
M	--	--	8
M	--	--	9
M	--	--	10
M	--	--	11
M	--	--	12
M	--	--	13
M	--	--	14
M	--	--	15
M	--	--	16
Es	F	3 yr.	17
M	F	5 yr.	18
M	F	7 yr.	19
Gs	F	3 yr.	20
M	F	4 yr.	21
M	--	--	22
M	--	--	23

Table 5. Synovial fluid analyses from the following normal carpal, elbow, shoulder, hip, stifle and hock joints

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys % absol.	Mono. %	Mono. % absol.	Lymph. %	Lymph. % absol.	Clas. %	Clas. % absol.
18	6-19-61	A	0.1	ct	N	N	7.4	0.40	66.40	8	32	8	32	80	430	4	16
19	6-20-61	A	0.1	ct	--	N	7.6	0	22.50	--		--		--		--	
20	9-8-61	A	0.12	c	N	N	7.2	0.20	0.01	0	0	40	80	52	104	8	16
21	4-11-62	A	0.12	c	N	N	7.3	0.09	2.18	0	0	0	0	0	0	0	0
2	4-25-62	A	0.25	c	F	N	7.4	0.33	0.13	0	0	20	67	80	266	0	0
6	4-18-62	A	0.5	c	V	N	7.1	0.87	0.07	0	0	24	208	76	658	0	0
38	3-13-62	A	0.5	c	N	N	7.0	0.26	0.63	0	0	28	71	72	184	0	0
39	1-24-62	A	0.25	c	--	N	7.1	0.09	1.13	0	0	28	25	72	64	0	0
22	12-22-61	A'	0.10	c	--	--	7.2	0	0	0	0	0	0	0	0	0	0
17	1-1-61	A'	0.25	c	N	N	--	0.24	0	9	22	75	180	5	12	11	26
21	4-11-62	A'	0.12	c	N	N	7.4	0.04	0.13	0	0	32	14	68	30	0	0
1	4-11-62	A'	0.50	c	V	N	7.5	0.35	0.40	0	0	68	238	28	98	4	14

Table 5. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys % absol.	Mono. % absol.	Lymph. % absol.	Clas. % absol.
37	3-28-62	A'	0.25	c	N	N	7.0	0.04	0.06	0 0	36 16	60 26	4 2
34	3-5-62	A'	0.25	c	N.	N	7.0	0.70	0.03	0 0	0 0	100 66	0 0
34	3-5-62	A'	0.25	c	N.	N	7.0	0.30	0.03	0 0	5 15	95 285	0 0
2	4-25-62	A'	0.50	c	P	N	7.4	0.66	0.13	0 0	0 0	0 0	0 0
2	4-25-62	B'	0.25	ct	N	N	7.4	0.04	6.26	0 0	28 12	72 32	0 0
1	4-11-62	B	0.25	c	N	N	7.5	0.31	6.46	0 0	12 37	88 272	0 0
21	4-11-62	C	0.25	c	P	N	7.5	0.13	0.04	0 0	40 52	60 78	0 0
2	4-25-62	C	0.50	c	V	N	7.1	0.93	0	0 0	68 634	32 299	0 0
17	1-1-61	C	0.25	c	N	N	--	0.5	0	0 0	87 479	6 33	7 38
24	12-22-61	C'	0.25	c	N	N	7.1	0.06	0	0 0	8 5	90 51	2 1
2	4-25-62	C'	0.25	c	V	N	7.2	0.95	0.22	0 0	69 658	31 296	0 0
4	6-19-61	C	0.12	c	N	N	7.8	0.55	0	0 0	8 44	89 490	3 16

Table 5. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys absol.	Mono. %	Mono. absol.	Lymph. %	Lymph. absol.	Clas. %	Clas. absol.
1	4-11-62	C'	0.50	c	V	N	7.5	0.66	3.71	4	26	28	185	68	449	0	0
25	6-20-61	C'	0.10	c	--	N	7.6	0	0	0	0	0	0	0	0	0	0
17	1-1-61	D	0.25	c	N	N	--	0.10	0	0	0	82	82	8	8	10	10
30	6-20-61	D	0.12	ct	--	N	7.6	0.70	88.8	--		--		--		--	
4	6-19-61	D	0.01	c	N	N	7.8	1.10	4.2	0	0	10	110	80	880	10	110
26	11-2-61	D	0.25	ct	P	N	7.2	0.72	3.10	0	0	96	276	4	12	0	0
27	11-2-61	D	0.25	ct	P	N	7.0	0.53	2.35	4	21	96	512	0	0	0	0
28	12-5-61	D	0.50	c	N	N	7.0	0.33	0	0	0	24	80	68	226	8	27
40	12-5-61	D	.01	c	--	N	7.0	--	--	0		0		0		0	
41	12-5-61	D	0.05	c	--	N	7.2	--	--	0		6		84		10	
43	10-24-61	D	0.25	c	--	N	7.0	0.11	0	0	0	24	27	68	75	0	0
31	9-8-61	D'	0.12	c	--	--	--	--	--	0		5		1		27	

Table 5. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys absol.	Mono. %	Mono. absol.	Lymph. %	Lymph. absol.	Clas. %	Clas. absol.
33	9-8-61	D'	0.12	c	--	--	--	--	--	1		70		22		7	
32	9-8-61	D'	0.25	c	--	--	--	--	--	0		74		19		7	
26	11-2-61	D'	1.0	c	N	N	7.4	0.71	0.53	0	0	84	597	10	71	6	43
27	11-2-61	D'	0.25	c	P	N	7.4	0.53	0.04	2	11	78	416	14	75	6	32
4	6-19-61	D'	0.1	c	--	--	7.8	2.90	75.20	0	0	16	464	84	2436	0	0
29	6-20-61	D'	0.1	ctl	--	N	7.6	0.25	320	--		--		--		--	
35	3-1-62	D'	0.75	c	--	N	7.5	0.24	0.17	0	0	0	0	32	78	68	166
40	12-5-61	D'	0.01	c	--	N	7.0	--	--	0		0		0		0	
41	12-5-61	D'	0.05	ct	--	N	7.2	--	--	2		90		7		1	
42	9-27-61	D'	0.5	ct	F	R	--	1.13	15.0	0	0	74	838	21	238	5	57
43	10-24-61	D'	0.25	c	--	N	7.0	0.07	0	0	0	11	7	89	59	0	0
44	12-5-61	D'	0.12	c	--	N	7.2	0.18	0	0	0	32	57	68	120	0	0

Table 5. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys % absol.	Mono. %	Mono. % absol.	Lymph. %	Lymph. % absol.	Clas. %	Clas. % absol.
8	10-24-60	E	0.08	c	--	--	--	--	--	2		86		10		2	
15	11-7-60	E	0.08	c	--	--	--	0.40	3.40	--		--		--		--	
11	10-24-60	E	0.25	c	--	--	--	--	--	1		67		31		1	
10	10-24-60	E	0.08	c	--	--	--	--	--	10		75		11		4	
9	10-24-60	E	0.08	c	--	--	--	--	--	12		51		36		1	
4	6-19-61	E	0.12	c	N	N	7.8	0.50	0.20	0	0	16	80	84	420	0	0
2	4-25-62	E	0.25	c	F	N	7.6	0.76	3.07	1	8	46	347	53	400	0	0
6	4-18-62	E	0.25	ct	P	N	7.4	0.53	39.22	4	21	14	75	82	437	0	0
5	6-20-61	E	0.25	c	N	N	7.8	0.60	1.40	4	24	24	144	60	360	12	72
7	11-7-60	E	0.25	c	N	N	--	0.20	0	0	0	82	163	10	30	8	16
16	12-28-60	E'	0.25	c	--	--	--	--	--	7		87		0		6	
12	11-7-60	E'	0.08	c	--	--	--	0.40	3.44	--		--		--		--	

Table 5. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys % absol.	Mono. % absol.	Lymph. % absol.	Clas. % absol.
13	12-28-60	E'	0.25	c	--	--	--	--	--	7	87	0	6
14	12-28-60	E'	0.25	c	--	--	--	--	--	5	84	8	3
4	6-19-61	E'	0.2	c	N	N	7.6	0.75	0.50	0 0	28 210	72 540	0 0
2	4-25-62	E'	0.50	c	V	N	7.3	1.18	0.87	0 0	50 589	50 589	0 0
7	11-7-60	E'	0.25	c	--	--	--	0.20	0	0 0	82 163	10 18	8 16
36	12-2-60	E'	0.12	c	N	--	--	0.30	0.75	--	--	--	--
45	5-29-60	F	0.20	ct	F	N	--	--	--	0	23	75	2
46	5-29-62	F	0.20	ct	F	N	--	0.16	5.45	0 0	19 29	73 113	8 12
46	5-29-62	F'	0.05	c	F	N	--	0.08	2.95	4 3	16 13	80 64	0 0
45	5-29-62	F'	0.20	ct	F	N	--	0.24	3.07	1 2	21 51	78 190	0 0

Table 6. Statistical analysis of synovial fluid properties from normal carpal joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	16	0.10 - 0.50	0.26 ± .04
pH	15	7.00 - 7.60	7.24 ± 0.05
Leukocytes/mm^3 in 1000	16	0 - 0.87	0.28 ± 0.013
Erythrocytes/mm^3 in 1000	16	0 - 66.40	5.80 ± 4.27
Pmn.* %	15	0 - 9	1.13 ± 0.77
Pmn. abs.**	15	0 - 32	3.60 ± 2.51
Monocytes %	15	0 - 75	24.27 ± 6.15
Monocytes abs.	15	0 - 238	65.40 ± 22.73
Lymphocytes %	15	0 - 100	52.53 ± 9.36
Lymphocytes abs.	15	0 - 658	148.20 ± 49.00
Clasmatocytes %	15	0 - 11	2.07 ± 0.90
Clasmatocytes abs.	15	0 - 26	4.93 ± 2.20
Mucin clot	13	N - V	
Viscosity	15	N	

*Polymorphonuclear leukocytes

**Absolute numbers

Table 7. Statistical analysis of synovial fluid properties from normal elbow joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	2	0.25	0.25
pH	2	7.40 - 7.50	7.45 ± 0
Leukocytes/mm^3 in 1000	2	0.04 - 0.31	0.17 ± 0.12
Erythrocytes/mm^3 in 1000	2	6.26 - 6.46	6.36 ± 0.10
Pmn.* %	2	0	0
Pmn. abs.**	2	0	0
Monocytes %	2	12 - 28	20 ± 8
Monocytes abs.	2	12 - 27	24.5 ± 12.50
Lymphocytes %	2	72 - 88	80 ± 7.45
Lymphocytes abs.	2	32 - 272	152 ± 120
Clasmatocytes %	2	0	0
Clasmatocytes abs.	2	0	0
Mucin clot	2	N	
Viscosity	2	N	

*Polymorphonuclear leukocytes

**Absolute numbers

Table 8. Statistical analysis of synovial fluid properties from normal shoulder joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	8	0.10 - 0.50	0.28 ± 0.0005
pH	7	7.10 - 7.80	7.40 ± 0.10
Leukocytes/mm^3 in 1000	8	0 - 0.95	0.48 ± 0.13
Erythrocytes/mm^3 in 1000	8	0 - 3.71	0.50 ± 0.45
Pmn.* %	8	0 - 4	0.50 ± 0.50
Pmn. abs.**	8	0 - 26	3.25 ± 3.24
Monocytes %	8	0 - 87	38.50 ± 11.65
Monocytes abs.	8	0 - 658	257.12 ± 101.20
Lymphocytes %	8	0 - 90	47.00 ± 12.38
Lymphocytes abs.	8	0 - 490	212.00 ± 69.30
Clasmatocytes %	8	0 - 7	1.50 ± 0.88
Clasmatocytes abs.	8	0 - 38	6.87 ± 4.86
Mucin clot	7	N - V	
Viscosity	8	N	

*Polymorphonuclear leukocytes

**Absolute numbers

Table 9. Statistical analysis of synovial fluid properties from normal hip joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	22	0.10 - 1.00	0.24 ± 0.05
pH	17	7.00 - 7.80	7.28 ± 0.07
Leukocytes/mm^3 in 1000	15	0.10 - 1.13	0.64 ± 0.18
Erythrocytes/mm^3 in 1000	15	0 - 320	12.84 ± 7.34
Pmn.* %	20	0 - 4	0.60 ± 0.29
Pmn. abs. **	13	0 - 21	2.46 ± 1.79
Monocytes %	20	0 - 96	43.60 ± 3.51
Monocytes abs.	13	0 - 838	266.62 ± 75.40
Lymphocytes %	20	0 - 89	33.95 ± 7.60
Lymphocytes abs.	13	0 - 2436	329.07 ± 186.80
Clasmatocytes %	20	0 - 68	8.25 ± 3.46
Clasmatocytes abs.	13	0 - 166	34.23 ± 14.18
Mucin clot	14	N - P	
Viscosity	18	N - R	

*Polymorphonuclear leukocytes

**Absolute numbers

Table 10. Statistical analysis of synovial fluid properties from normal stifle joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	18	0.08 - 0.50	0.20 ± 0.02
pH	6	7.30 - 7.80	7.58 ± 0.08
Leukocytes/ mm^3 in 1000	11	0.20 - 1.18	0.53 ± 0.08
Erythrocytes/ mm^3 in 1000	11	0 - 39.22	4.80 ± 3.46
Pmn.* %	15	0 - 12	3.53 ± 1.01
Pmn. abs.**	8	0 - 24	6.62 ± 3.46
Monocytes %	15	14 - 87	58.60 ± 7.12
Monocytes abs.	8	75 - 589	221.37 ± 60.50
Lymphocytes %	15	0 - 84	34.47 ± 7.80
Lymphocytes abs.	8	18 - 589	349.25 ± 75.70
Clasmatocytes %	15	0 - 12	3.40 ± 0.98
Clasmatocytes abs.	8	0 - 72	13.00 ± 8.70
Mucin clot	8	N - V	
Viscosity	7	N	

* Polymorphonuclear leukocytes

** Absolute numbers

Table 11. Statistical analysis of synovial fluid properties from normal hock joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	4	0.05 - 0.20	0.16 ± 0.03
pH	0	---	---
Leukocytes/ mm^3 in 1000	3	0.08 - 0.24	0.16 ± 0.05
Erythrocytes/ mm^3 in 1000	3	2.95 - 5.45	3.82 ± 0.81
Pmn.* %	4	0 - 4	1.25 ± 0.94
Pmn. abs.**	3	0 - 3	1.88 ± 1.18
Monocytes %	4	16 - 23	19.75 ± 1.49
Monocytes abs.	3	13 - 51	31.16 ± 11.13
Lymphocytes %	4	73 - 80	76.50 ± 1.57
Lymphocytes abs.	3	64 - 190	122.49 ± 34.90
Clasmatocytes %	4	0 - 8	2.25 ± 1.80
Clasmatocytes abs.	3	0 - 12	4.13 ± 4.13
Mucin clot	4	F	
Viscosity	4	N	

* Polymorphonuclear leukocytes

** Absolute numbers

Table 12. Statistical analysis of synovial fluid properties from normal carpal, elbow, shoulder, hip, stifle, and hock joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	70	0.01 - 1.00	0.24 ± 0.02
pH	47	7.00 - 7.80	7.33 ± 0.04
Leukocytes/mm^3 in 1000	55	0 - 2.90	0.43 ± 0.06
Erythrocytes/mm^3 in 1000	55	0 - 320	12.15 ± 6.21
Pmn.* %	64	0 - 12	1.38 ± 0.34
Pmn. abs.**	47	0 - 32	3.63 ± 1.22
Monocytes %	64	0 - 96	39.72 ± 4.09
Monocytes abs.	47	0 - 838	230.77 ± 24.80
Lymphocytes %	64	0 - 100	44.16 ± 3.19
Lymphocytes abs.	47	0 - 2436	245.60 ± 55.29
Clasmatocytes %	64	0 - 68	4.20 ± 1.17
Clasmatocytes abs.	47	0 - 166	14.69 ± 4.57
Mucin clot	42	N - F	
Viscosity	53	N - R	

*Polymorphonuclear leukocytes

**Absolute numbers

Since the number of cases examined was quite large, the results of the laboratory analyses of normal synovial fluid from the six articulations must be presented separately (tables 5-11). For the purpose of comparison, in the tabulation of the characteristics of the normal synovial fluids, all samples are considered as a group (table 12). Normal joint fluid values established by this study vary from one articulation to another. Therefore, each joint was considered to be a separate entity.

The properties of diseased joint fluid (tables 15, 18, 21, 24-28) may be compared to those of normal fluid by referring to these tables of normal values for each articulation.

Table 13. Animal identification key for Table 14

Breed	Sex	Age	Animal Number	Duration*
Cs	F	7 yr.	100	8 days
B	M	6 yr.	101	3 wks.
Bt	M	7½yr.	102	3 days
Is	M	3½yr.	103	2 wks.
Cs	M	9½yr.	104	1 wk.
Bt	F	2 yr.	105	2 days

*Duration time established from onset of lameness to clinical examination.

Table 14. Synovial fluid analyses from stifle joints with a ruptured anterior cruciate ligament less than 3 weeks duration

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys % absol.	Mono. % absol.	Lymph. % absol.	Clas. % absol.
100	9-25-61	E	0.25	s	V	R	7.2	0.02	44.80	0 0	0 0	0 0	0 0
102	6-19-61	E	1.0	s	V	G	7.0	0.40	63.20	0 0	9 36	19 76	72 288
104	8-3-61	E	1.5	s	V	N	7.2	0.18	29.71	0 0	4 7	46 81	48 85
101	6-14-61	E'	0.25	s	F	R	7.6	0.26	0	0 0	20 52	30 78	50 130
103	11-15-60	E'	2.5	s'l	P	--	--	4.10	20.3	0 0	63 693	21 231	16 176
105	9-29-61	E'	2.0	s	P	R	7.0	2.39	20.00	28 669	0 0	72 1719	0 0

Table 15. Statistical analysis of synovial fluid properties from stifle joints with a ruptured anterior cruciate ligament less than 3 weeks duration

Analyses	Number of cases	Range	Mean ±
Amount (cc)	6	0.25 - 2.00	1.25 ± .37
pH	5	7.00 - 7.60	7.20 ± .11
Leukocytes/mm^3 in 1000	6	.02 - 2.39	.73 ± .36
Erythrocytes/mm^3 in 1000	6	0 - 44.80	29.67 ± 8.95
Pmn.* %	6	0 - 28	4.67 ± 4.7
Pmn. abs.**	6	0 - 669	111.50 ± 112
Monocytes %	6	0 - 63	16.00 ± 9.89
Monocytes abs.	6	0 - 693	131.33 ± 113
Lymphocytes %	6	0 - 72	31.33 ± 10.20
Lymphocytes abs.	6	0 - 1719	364.17 ± 272
Clasmatocytes %	6	0 - 72	31.00 ± 12.40
Clasmatocytes abs.	6	0 - 288	113.17 ± 45
Mucin clot	6	F - V	
Viscosity	5	N - G	

*Polymorphonuclear leukocytes

**Absolute numbers

Table 16. Animal identification key for Table 17

Breed	Sex	Age	Animal Number	Duration*
Be	F	2½ yr.	110	3 mos.
Bm	M	2 yr.	110	6 mos.
B	F	9 yr.	112	4 mos.
M	F	3 yr.	113	3 mos.
Mp	M	4½ yr.	114	2 mos.
L	M	4½ yr.	115	6 mos.
M	F	10 yr.	116	6 wks.
Ss	F	10 yr.	117	3 mos.
Cs	F	4 yr.	118	2 mos.
Bm	F	1½ yr.	119	10 mos.
B	F	8 yr.	120	10 mo.
Eb	F	16 mo.	121	2 mos.
B	F	3 yr.	122	3 mos.
Cs	F	5 yr.	123	2 mos.
M	F	6 yr.	124	6 wks.
Stb	F	3½ yr.	125	3 mos.
Gs	F	10 yr.	126	1 yr.
Mp	F	5 yr.	127	2 mos.

*Duration time established from onset of lameness to clinical examination.

Table 17. Synovial fluid analyses from stifle joints with a ruptured anterior cruciate ligament more than 3 weeks duration

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys % absol.	Mono. % absol.	Lymph. % abol.	Clas. % absol.
110	12-22-61	E	0.25	s	--	N	7.4	1.53	21.40	p 0	2 31	91 1395	6 92
111	1-5-62	E	0.50	lc'	P	N	7.6	2.56	0.24	0 0	1 26	87 307	12 2223
112	2-1-62	E	1.0	y	V	G	7.1	0.11	0	0 0	1 1	84 89	15 16
114	3-9-62	E	0.25	c'	P	N	7.0	0.48	3.89	0 0	25 119	67 320	8 38
115	10-2-61	E	2.0	s	P	--	7.2	0.190	0	0 0	9 17	61 115	30 56
116	9-26-61	E	1.75	yt	N	R	7.1	0.86	0	3 26	7 60	81 693	9 77
117	10-5-61	E	0.25	c	N	R	7.1	0.11	0.01	2 3	8 11	37 49	53 70
120	6-9-61	E	0.25	c'	N	N	7.6	0.25	60.0	10 25	10 25	80 200	0 0
121	5-24-61	E	1.0	s'l	F	G	7.8	1.5	0.80	2 30	6 90	72 1080	20 300
123	3-1-61	E	0.5	s'l	N	G	6.25	1.0	1.00	1 63	5 313	19 1187	75 4687
124	2-2-62	E	2.25	s's	P	--	--	2.75	54.40	6 165	19 523	69 1897	9 248
124	4-14-62	E	0.5	s	F	--	--	6.00	0	--	--	--	--

Table 17. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys % absol.	Mono. %	Mono. % absol.	Lymph. %	Lymph. % absol.	Clas. %	Clas. % absol.
124	5-25-62	E	0.2	c's	F	--	7.8	0	38.0	--	--	--	--	--	--	--	--
125	8-28-61	E	2.0	c'y	P	N	7.3	0.78	2.13	1	8	10	78	48	373	41	318
126	11-28-60	E	2.0	s	P	--	--	2.15	70.00	4	86	54	1164	0	0	42	903
113	11-20-61	E'	2.0	s	V	N	7.2	0.87	0	0	0	78	675	22	191	0	0
118	6-12-61	E'	0.2	s's	F	N	7.6	1.20	8.20	0	0	10	120	0	0	90	1080
119	6-7-61	E'	2.5	s'yt	P	N	7.6	1.00	29.80	24	240	30	300	36	360	10	100
120	6-9-61	E'	0.25	c	N	N	7.4	0.20	0.60	0	0	4	8	0	0	96	192
122	3-24-61	E'	0.5	c's	N	R	7.5	0.60	24.70	1	6	4	25	81	486	14	84
126	11-28-60	E'	0.25	ct	N	--	--	0.34	4.50	5	17	81	275	4	14	10	34
127	2-5-62	E'	2.0	s	V	G	7.1	0.67	28.20	0	0	5	33	80	533	15	100
127	2-19-62	E'	0.25	cy	--	N	7.1	0.27	8.27	0	0	4	11	80	213	16	43
127	4-12-62	E'	0.50	c'y	P	R	8.0	0.76	5.20	0	0	36	272	58	438	6	45

Table 18. Statistical analysis of synovial fluid properties from stifle joints with a ruptured anterior cruciate ligament more than 3 weeks duration

Analyses	Number of cases	Range	Mean ±
Amount (cc)	24	0.20 - 2.25	0.97 ± 0.17
pH	19	7.0 - 8.0	7.40 ± 0.067
Leukocytes/mm^3 in 1000	24	0 - 6.25	1.31 ± 0.34
Erythrocytes/mm^3 in 1000	24	0 - 70.00	15.06 ± 4.30
Pmn.* %	22	0 - 24	2.68 ± 1.15
Pmn. abs.**	22	0 - 240	30.41 ± 13.00
Monocytes %	22	1 - 81	18.60 ± 5.09
Monocytes abs.	22	1 - 1161	189.68 ± 61.00
Lymphocytes %	22	0 - 91	51.68 ± 7.20
Lymphocytes abs.	22	0 - 1897	451.82 ± 109.00
Clasmatocytes %	22	0 - 96	26.23 ± 6.00
Clasmatocytes abs.	22	0 - 4687	486.64 ± 230
Mucin clot	22	N - V	
Viscosity	18	N - G	

*Polymorphonuclear leukocytes

**Absolute numbers

The diagnosis of a ruptured anterior cruciate ligament was made using the criteria of sudden lameness and anterior drawer movement. If surgery was performed, the ligament was examined grossly. In all surgical cases, the ligament was found to be ruptured.

For the animals examined at this clinic, an interval of approximately three weeks between onset of lameness and treatment appeared to be a critical period. When the interval was less than three weeks, surgical treatment generally produced satisfactory functional results. However, when the interval exceeded approximately three weeks, the results from surgical treatment were not as satisfactory. This interval varied slightly, depending upon the degree of activity of the dog. For the purpose of this discussion, this time interval has been used as a criterion for classifying joint disease (those cases more or less than 3 weeks' duration) (tables 14-18).

It is interesting to compare the absolute polymorphonuclear leukocyte count in tables 15 and 18 and the normal absolute count in table 10. The count is higher in the more acute cases (those cases less than 3 weeks' duration). The per cent and absolute clasmatocyte counts are higher than normal for both divisions. Further, the absolute clasmatocyte count is higher in the more chronic cases (those cases more than 3 weeks' duration).

Table 19. Animal identification key for Table 20

Breed	Sex	Age	Animal Number
B	M	6 yr.	80
L	F	$3\frac{1}{2}$yr.	81
Mp	M	8 mo.	82
Gs	M	13mo.	83
V	F	3 yr.	84
Gs	M	7 mo.	85
Gos	F	8 mo.	86

Table 20. Synovial fluid analyses from hip joints with dysplasia

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys % absol.	Mono. %	Mono. % absol.	Lymph. %	Lymph. % absol.	Clas. %	Clas. % absol.
81	9-18-61	D	0.12	c	--	N	7.1	--	--	--	--	--	--	--	--	--	--
82	10-9-61	D	0.12	c	--	N	7.4	0.60	0.33	0	0	18	108	26	156	56	348
83	7-19-61	D	0.25	l	--	N	--	--	--	0		4		28		68	
85	11-18-60	D	0.25	c	P	N	--	0.877	2.50	0	0	69	605	21	184	10	88
85	12-1-60	D	0.25	c	P	--	--	0.05	2.80	--	--	--	--	--	--	--	--
86	11-9-60	D	1.0	cs	F	R	--	0.70	2.433	17	119	22	154	23	161	38	266
86	12-9-60	D	0.5	ct	--	--	--	3.47	5.00	3	104	32	1109	8	277	57	1976
86	12-1-60	D'	0.25	c	N	N	--	2.80	0.05	0	0	46	1288	4	112	50	1400
80	10-7-61	D'	0.12	c	--	N	7.4	10.288	0.115	0	0	1	3	55	158	44	127
81	9-18-61	D'	0.12	c	--	N	7.0	--	--	2		64		30		4	
81	10-2-61	D'	0.25	c	--	--	--	0.466	2.40	0	0	7	33	43	200	50	233
84	5-25-61	D'	0.50	ls	F	R	7.6	0.90	10.60	5	45	29	261	23	207	43	387

Table 20. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys % absol.	Mono. % absol.	Lymph. % absol.	Clas. % absol.
85	11-18-60	D'	1.75	cs	N	--	--	0	3.40	0 0	0 0	0 0	0 0
85	12-1-60	D'	0.25	c	P	--	7.05		2.00	-- --	-- --	-- --	-- --
86	11-9-60	D'	2.5	c	P	R	--	0.60	0.92	0	35 210	20 120	45 270
86	11-9-60	D'	0.5	ct	--	--	--	2.022	5.0	30 667	16 324	18 364	36 728

Table 21. Statistical analysis of synovial fluid properties from hip joints with dysplasia

Analyses	Number of cases	Range	Mean ±
Amount (cc)	16	0.12 - 1.75	0.55 ± 0.16
pH	5	7.0 - 7.6	7.30 ± 0.10
Leukocytes/mm^3 in 1000	13	0 - 3.47	0.99 ± 0.30
Erythrocytes/mm^3 in 1000	13	0.05 - 10.60	2.89 ± 0.78
Pmn.* %	13	0 - 30	4.39 ± 2.5
Pmn. abs.**	13	0 - 667	71.92 ± 51.00
Monocytes %	13	0 - 69	26.39 ± 6.2
Monocytes abs.	13	0 - 1288	315.00 ± 119
Lymphocytes %	13	0 - 55	23.00 ± 4.12
Lymphocytes abs.	13	0 - 364	149.15 ± 27
Clasmatocytes %	13	0 - 68	38.54 ± 5.8
Clasmatocytes abs.	13	0 - 1976	447.92 ± 27
Mucin clot	8	N - P	
Viscosity	10	N - R	

*Polymorphonuclear leukocytes

**Absolute numbers

The diagnosis of hip dysplasia was made from radiographs. The joint fluids from these cases had an average total leukocyte count slightly above normal (tables 9 and 21). The per cent and absolute polymorphonuclear cell counts were also above normal. It is interesting to note that the clasmatocyte counts were elevated.

Table 22. Animal identification key for Table 23

Breed	Sex	Age	Animal Number
D	F	2 yr.	60
W	F	9 mo.	61
W	F	15mo.	62
Mp	M	2 yr.	63
B	M	9 yr.	66*
Gp	M	3 yr.	67
C	F	4 yr.	68
Gr	F	4 yr.	70
M	M	2 yr.	71
Gs	M	4 yr.	142
M	F	6 yr.	72

* Staphylococcus aureus isolated from culture.

Table 23. Synovial fluid analyses of possible septic arthritides from the carpal, shoulder, hip, stifle and hock joints

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys % absol.	Mono. %	Mono. % absol.	Lymph. %	Lymph. % absol.	Clas. %	Clas. % absol.
62	4-18-61	A	0.20	ct	N	N	--	1.35	16.7	60	810	5	68	29	392	6	81
67	6-5-61	A	1.50	c'l	P	N	7.5	21.7	0.45	92	19964	4	868	2	434	2	434
67	7-7-61	A	2	c'l	V	N	7.6	19.9	0.85	--		--		--		--	
70	1-13-61	A'	0.25	s's	V	R	6.5	11.3	630	--		--		--		--	
61	1-31-61	C'	1.0	clt	P	R	7.0	14.5	6.6	38	5510	30	4350	10	1450	22	3190
60	3-30-61	D	0.5	s	N	N	--	10.7	282	23	2461	3	321	48	5186	26	2782
60	4-7-61	D	0.1	s	--	--	7.4	--	--	20		0		0		80	
71	9-21-61	D	0.25	c	--	--	--	--	--	70		22		2		6	
63	2-6-62	E	0.25	--	--	--	7.1	2.95	3.86	59	1743	0	0	19	561	22	650
66	6-29-62	E	0.50	ct	N	--	--	4.4	0.09	51	2244	8	352	39	1716	2	88
68	3-24-61	E	0.1	cs	--	--	--	--	--	9		7		45		39	
68	4-4-61	E	0.1	s'l	P	R	7.0	29	9	28	13920	28	8120	0	0	24	6960

Table 23. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cc mm in 1000	Erythrocytes /cu mm in 1000	Polys % absol.	Mono. % absol.	Lymph. % absol.	Clas. % absol.
68	5-15-61	E	1.0	c'l	V	R	6.8	40	0	84 33600	2 800	10 4000	4 1600
66	6-29-61	E'	0.50	ct	N	--	--	0.27	0.26	76 209	0 0	24 66	0 0
68	3-24-61	E'	0.20	cs	E'	R	--	3.7	14.8	1 37	2 74	95 3515	2 74
68	4-4-61	E'	0.50	cs	F	N	7.0	18.8	53.6	88 16544	2 376	10 1880	0 0
68	5-15-61	E'	1.0	cs	P	R	7.0	130	30	82 106,600	4 5200	7 9100	0 0
72	5-25-61	E'	2.5	c'l	P	--	7.0	11.10	0.40	95 10545	2 222	3 333	0 0
72	4-14-61	E'	0.66	c's	F	--	--	2.85	6.0	--	--	--	--
142	4-3-62	F	0.25	cs	V	N	7.2	6.2	10.0	24 150	12 749	60 3746	4 250

Table 24. Statistical analysis of synovial fluid properties of possible septic arthritides from carpal joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	4	0.20 - 1.50	0.99 ± 0.45
pH	3	6.50 - 7.50	7.20 ± 0.35
Leukocytes/mm^3 in 1000	4	1.35 - 21.70	13.56 ± 4.66
Erythrocytes/mm^3 in 1000	4	0.45 - 630	162 ± 156
Pmn.* %	2	60 - 92	76 ± 16
Pmn. abs.**	2	810 - 19,964	10,387 ± 9,577
Monocytes %	2	4 - 5	4.50 ± 0.50
Monocytes abs.	2	68 - 868	468 ± 400
Lymphocytes %	2	2 - 29	15.50 ± 13.40
Lymphocytes abs.	2	392 - 434	413 ± 21
Clasmatocytes %	2	2 - 6	4.00 ± 2.00
Clasmatocytes abs.	2	81 - 434	257.50 ± 176
Mucin clot	4	N - V	
Viscosity	4	N - R	

*Polymorphonuclear leukocytes

**Absolute numbers

Table 25. Statistical analysis of synovial fluid properties of a possible septic arthritis from the shoulder joint

Analyses	Number of cases	Range	Mean ±
Amount (cc)	1		1.00
pH	1		7.00
Leukocytes/mm^3 in 1000	1		14.50
Erythrocytes/mm^3 in 1000	1		6.60
Pmn.* %	1		38
Pmn. abs.**	1		5510
Monocytes %	1		30
Monocytes abs.	1		4350
Lymphocytes %	1		10
Lymphocytes abs.	1		1450
Clasmatocytes %	1		22
Clasmatocytes abs.	1		3190
Mucin clot	1		P
Viscosity	1		R

*Polymorphonuclear leukocytes

**Absolute numbers

Table 26. Statistical analysis of synovial fluid properties of possible septic arthritides from hip joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	3	0.10 - 0.50	0.28 ± 0.14
pH	1	----	----
Leukocytes/mm^3 in 1000	1	----	----
Erythrocytes/mm^3 in 1000	1	----	----
Pmn.* %	3	20 - 70	37.67 ± 16.49
Pmn. abs.**	1	----	----
Monocytes %	3	0 - 22	8.33 ± 6.89
Monocytes abs.	1	----	----
Lymphocytes %	3	0 - 48	16.67 ± 15.67
Lymphocytes abs.	1	----	----
Clasmatocytes %	3	6 - 80	37.33
Clasmatocytes abs.	1	----	----
Mucin clot	1	----	N
Viscosity	1	----	N

*Polymorphonuclear leukocytes

**Absolute numbers

Table 27. Statistical analysis of synovial fluid properties of possible septic arthritides from stifle joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	11	0.10 - 2.50	0.67 ± 0.20
pH	6	6.80 - 7.10	6.98 ± 0.04
Leukocytes/mm^3 in 1000	10	0.27 - 130	24.30 ± 12.70
Erythrocytes/mm^3 in 1000	10	0 - 53.60	11.80 ± 5.58
Pmn.* %	10	1 - 95	57.30 ± 10.70
Pmn. abs.**	9	37 - 106,600	20604.67 ± 11,345
Monocytes %	10	0 - 28	5.50 ± 2.63
Monocytes abs.	9	0 - 8120	1,682.67 ± 975
Lymphocytes %	10	0 - 95	25.20 ± 9.07
Lymphocytes abs.	9	0 - 9100	2,352.33 ± 973
Clasmatocytes %	10	0 - 39	9.30 ± 4.39
Clasmatocytes abs.	9	0 - 6960	1,041.33 ± 760
Mucin clot	9	N - V	
Viscosity	6	N - R	

*Polymorphonuclear leukocytes

**Absolute numbers

Table 28. Statistical analysis of synovial fluid properties of a possible septic arthritis from a hock joint

Analyses	Number of cases	Range	Mean ±
Amount (cc)	1		0.25
pH	1		7.20
Leukocytes/mm^3 in 1000	1		6.20
Erythrocytes/mm^3 in 1000	1		10.00
Pmn.* %	1		24
Pmn. abs.**	1		150
Monocytes %	1		12
Monocytes abs.	1		749
Lymphocytes %	1		60
Lymphocytes abs.	1		3746
Clasmatocytes %	1		4
Clasmatocytes abs.	1		250
Mucin clot	1		V
Viscosity	1		N

*Polymorphonuclear leukocytes

**Absolute numbers

Table 29. Statistical analysis of synovial fluid properties of possible septic arthritides from the carpal, shoulder, hip, stifle and hock joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	20	0.10 - 1.50	0.67 ± 0.15
pH	12	6.5 - 7.6	7.09 ± .09
Leukocytes/mm^3 in 1000	17	0.27 - 130	19.34 ± 7.40
Erythrocytes/mm^3 in 1000	17	0 - 282	62.62 ± 39
Pmn.* %	17	1 - 95	54.12 ± 7.40
Pmn. abs.**	14	37 - 106,600	15,309.79 ± 7498
Monocytes %	17	0 - 30	7.71 ± 2.40
Monocytes abs.	14	0 - 8120	1,535.71 ± 668
Lymphocytes %	17	0 - 95	23.71 ± 6.40
Lymphocytes abs.	14	0 - 9100	2,312.79 ± 689
Clasmatocytes %	17	0 - 80	14.47 ± 5.00
Clasmatocytes abs.	14	0 - 9100	1,800.64 ± 760
Mucin clot	16	N - V	
Viscosity	12	N - R	

*Polymorphonuclear leukocytes

**Absolute numbers

The septic arthritis cases were diagnosed only upon the bases of total leukocyte and polymorphonuclear cell counts. A positive diagnosis of septic joint disease can only be made following isolation of a bacterial organism. It has been reported[22] that bacterial isolates from fluid obtained from infected human articulations are difficult to obtain. The results of this study confirm this finding. This difficulty may be either due to the very active phagocytosis by mononuclear phagocytes or to inadequate culturing techniques.

A tabulation of the laboratory analyses of the samples obtained from the carpus, shoulder, hip, stifle, and hock appear in tables 24-28, respectively. For the purpose of comparison, in the tabulation of the characteristics of all septic arthritis cases, all the samples are considered as a group (table 29). The total leukocyte count is considerably higher than in normal fluids. The erythrocyte count is also elevated. The differential and absolute polymorphonuclear leukocyte counts are substantially above normal. The absolute clasmatocyte count is above normal in all cases.

Table 30. Animal identification key for Table 31

Breed	Sex	Age	Animal Number
Bm	F	4 yr.	130
Es	M	3 yr.	131
Ep	M	3 yr.	132
S	M	8 mo.	133
Gs	M	6 mo.	134
Ne	M	3 yr.	135
Ba	M	3 yr.	136
Da	F	4 yr.	137
Gs	M	4 yr.	138
Ba	F	1 yr.	139
Is	F	8 mo.	140
Cs	F	5 yr.	141
Gs	M	4 yr.	142

Table 31. Synovial fluid analyses of unclassified traumatic arthritides of unknown etiology from the carpal, elbow, shoulder, stifle and hock joints

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys % absol.	Mono. %	Mono. % absol.	Lymph. %	Lymph. % absol.	Clas. %	Clas. % absol.
130	1-29-62	A	0.25	cy	--	N	7.0	0.20	0.13	0	0	0	0	79	158	21	42
131	1-24-62	A	2.0	cyt	N	R	7.1	0.71	2.8	0	0	3	21	79	562	18	128
132	9-5-61	A	0.25	ct	N	R	--	0.35	13.6	4	14	56	199	24	85	16	57
138	3-13-61	A'	0.25	cl	F	N	7.5	1.5	3.0	1	15	5	75	81	1215	13	195
133	2-16-62	B	0.25	cy	--	N	7.4	1.6	2.47	0	0	12	189	30	473	58	915
133	3-10-62	B	0.10	c	--	N	--	--	--	0	0	28		44		28	
134	3-30-62	B'	0.25	cs	P	N	7.1	1.2	5.8	8	96	16	192	67	804	9	108
135	2-2-61	C	0.10	c	--	--	--	--	--	2		70		14		14	
136	11-7-60	C	0.50	c	--	R-	--	0.30	0	0	0	63	189	7	21	30	90
137	8-25-61	C'	0.10	c	--	--	--	--	--	0		70		10		20	
138	3-10-61	C'	0.30	cl	N	N	7.5	2.2	8.2	1	22	6	132	35	770	58	1276
141	11-27-61	E	0.25	c	--	N	7.4	--	--	4		4		40		52	

Table 31. (Continued)

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys %	Polys % absol.	Mono. %	Mono. % absol.	Lymph. %	Lymph. % absol.	Clas. %	Clas. % absol.
141	3-8-62	E	0.1	c	P	N	--	1.6	1.8	2	32	40	640	43	688	15	240
139	11-21-60	E'	0.5	c	P	N	--	3.2	.13	0	0	80	2524	18	568	2	63
140	4-26-61	E'	0.5	c	F	N	--	0.42	0	0	0	28	118	28	118	44	186
140	5-8-61	E'	0.2	c	N	N	7.6	0.50	0	1	5	26	130	23	115	40	200
141	11-27-61	E'	0.1	ct	--	N	7.4	0.37	0	--		--		--		--	
141	3-8-62	E'	0.25	cs	P	N	7.1	0.64	13.2	0	0	1	6	91	586	8	52
142	2-22-62	F	2.00	cy	P	R	7.7	0.31	0	0	0	18	56	80	249	2	6
142	3-8-62	F	0.25	cs	P	N	7.3	.19	28.1	0	0	2	4	98	185	0	0

Table 32. Statistical analysis of synovial fluid properties of unclassified traumatic arthritides of unknown etiology from the carpal, elbow, shoulder, stifle and hock joints

Analyses	Number of cases	Range	Mean ±
Amount (cc)	20	0.10 - 2.00	.43 ± .49
pH	12	7.0 - 7.7	7.34 ± .063
Leukocytes/mm^3 in 1000	16	.19 - 2.20	.96 ± .68
Erythrocytes/mm^3 in 1000	16	0 - 28.10	4.95 ± 1.90
Pmn.* %	19	0 - 8	1.21 ± .47
Pmn. abs.**	15	0 - 96	12.27 ± 6.50
Monocytes %	19	0 - 80	27.79 ± 6.20
Monocytes abs.	15	0 - 2524	285.73 ± 165
Lymphocytes %	19	7 - 98	46.90 ± 6.80
Lymphocytes abs.	15	21 - 1215	438.40 ± 86
Clasmatocytes %	19	0 - 58	23.58 ± 4.20
Clasmatocytes abs.	15	0 - 1296	231.20 ± 94
Mucin clot	12	N - P	
Viscosity	18	N - R	

*Polymorphonuclear leukocytes

**Absolute numbers

Those cases diagnosed as unclassified traumatic arthritis could not be classified as to etiology, but instead were grouped using clasmatocyte counts and clinical symptom of lameness (with an unknown etiology) as criteria. For the purpose of comparison, in the tabulation of the characteristics of these cases, all samples are considered as a group (tables 31 and 32).

Table 33. Animal identification key for Table 34

Breed	Sex	Age	Animal Number	Diagnosis
L	M	6 yr.	90	Gunshot wound involving joint capsule
Gd	F	6 yr.	91	Osteogenic sarcoma of radius (distal)
Stb	M	7 mo.	92	Lateral luxation of patella
Gd	M	7 mo.	93	Osteochondritis dissecans
Gs	M	4 yr.	95	Ununited anconeal process

Table 34. Synovial fluid analyses of miscellaneous arthritides

Animal Number	Date	Articulation	Amount in cc	Nature	Mucin Clot	Viscosity	pH	Leukocytes /cu mm in 1000	Erythrocytes /cu mm in 1000	Polys % absol.	Mono. % absol.	Lymph. % absol.	Clas. % absol.
91	10-28-61	A	1.0	y	P	N	7.4	0.55	0	--	--	--	--
95	5-18-62	B'	1.0	ct	V	R	7.6	1.53	1.11	0 0	14 215	52 796	34 521
93	11-22-60	C	0.3	s	N	N	--	0.07	0.20	4 3	56 37	38 25	2 1
93	1-23-61	C	1.0	c	N	N	--	0.10	0.19	0 0	31 31	21 22	48 49
93	2-15-61	C	1.0	ct	F	R	--	2.95	94.00	4 118	8 236	10 295	78 2301
93	4-5-61	C	0.1	c	--	--	--	--	--	4	0	96	0
93	11-11-60	C'	0.25	ct	N	N	--	0.11	5.00	4 7	52 89	40 68	4 7
93	1-23-61	C'	1.0	c	N	N	--	0.13	0.2	0 0	7 9	38 51	55 73
93	4-5-61	C'	1.25	s	P	R	--	0.80	59.20	4 32	4 32	49 392	43 344
90	7-24-61	E	0.5	C'	V	G	7.0	3.90	22.50	31 1209	24 936	42 1638	3 117
92	12-2-60	E	1.0	s	P	R	--	0.30	11.40	--	--	--	--
92	1-16-61	E'	1.0	cl	N	--	--	1.70	1.35	0 0	28 501	2 36	70 1252

Diseased joints of known etiology, but where case numbers were no more than 1, were grouped in the category of miscellaneous arthritides.

A gunshot wound case (animal number 90) was placed in this classification for two reasons. The injury had occurred 10 days prior to the examination. It was not known whether the elevated polymorphonuclear cell counts resulted from an infection following the gunshot or from trauma to the joint capsule produced by the shot. This can be either a traumatic arthritis, a septic arthritis, or both.

With reference to the osteochondritis dissecans case (animal number 93), it is interesting to note the variations in the clasmatocyte counts (table 34) as compared to normal counts (table 8). In those fluid samples where the clasmatocyte count is within the normal range, one may suspect that a loose joint body (an articular cartilage fragment) had caused either locking of the articulation or restriction of movement. Where this occurs an arthritis may not develop. In those samples where the count was abnormal, one may suspect that abnormal friction produced by a loose joint body, in a joint where movement has not been restricted, may produce cellular changes. In this situation, an arthritis, with subsequent lameness, would be present.

The ununited anconeal process (in animal number 95) produced a traumatic arthritis and elevated clasmatocyte counts.

CONCLUSIONS

Normal joint fluid values established by this study have been found to vary from one articulation to another. Therefore, each joint was considered to be a separate entity.

If polymorphonuclear leukocytes are present in numbers exceeding approximately 150/mm^3 or the differential cell count exceeds 20%, a diagnosis of a possible septic arthritis should be considered. A cellular count of this nature would justify an attempt to culture the synovial fluid.

If the clasmatocyte count exceeds approximately 150/mm^3, or the differential cell count exceeds 30%, one should consider a diagnosis of traumatic arthritis.

In cases where both the clasmatocyte and polymorphonuclear cell counts are above normal, a tentative diagnosis of septic arthritis should be made.

In all cases, subsequent synovial fluid samples should be taken for analysis to evaluate the response of the diseased joint to treatment.

Using synovial fluid analysis, it is possible to determine the presence or absence of arthritis. It is also possible to differentiate arthritides of traumatic etiology from those of infectious etiology. In some cases, a

differentiation may be made between acute and chronic joint diseases.

From the results of this study, it is concluded that synovial fluid analysis is a useful adjunct to the diagnosis of canine joint diseases.

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