THE PATHOLOGY OF EQUINE FISTULOUS WITHERS

by

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INTRODUCTION

For many years, the disease process designated fistulous withers has been considered as one of the most unsatisfactory diseased conditions that the veterinarian has been called upon to treat. Several causes for the condition have been advanced. Before the turn of the century veterinarians generally attributed the cause of the disease process to contusions of the withers. There are veterinarians who still believe that traumata play a contributing role. Early bacteriological examinations of the exudate from unopened cases of fistulous withers were negative. Subsequently, the organism, Brucella abortus, was isolated from the exudate of the disease process by bacteriologists in widely separated countries of the world. Recently, the organism, Actinomyces bovis, has been isolated by anaerobic methods from aseptically collected material. Parasitologists have incriminated Onchocerca cervicalis in the development of fistulous withers. These discoveries suggest that the etiology of fistulous withers is a complicated process.

This study deals primarily with the gross and microscopic pathology of the lesions and the possible relation to the etiological agents that have been found by other investigators. A review of the literature discloses that this phase of fistulous withers research has been inadequately studied.

MATERIAL AND METHODS

The data presented in this paper is based on the study of equine material collected in the School of Veterinary Medicine over a period of approximately two years and includes 10 clinical cases of fistulous withers. In every case representative pieces of the involved ligamentum nuchae and the bursal sac enclosing the exudate were prepared for microscopic examination. In one case two of the spinous processes of the thoracic vertebrae were involved in the disease process, so they were decalcified and sectioned. All of the tissues were fixed by Zenker's method, embedded in tissuemat, sectioned with a microtome, and stained with hematoxylin and eosin.

In addition, a study was made of the incidence of brucellosis in equines presented at the Kansas State College veterinary clinic having fistulous withers as compared with those presented for other conditions.

REVIEW OF THE LITERATURE

The literature on fistulous withers has been divided into three parts; namely, traumatic causes, parasitic findings, and bacteriological investigations.

In several instances reference is made to poll evil. This is a disease of the poll that appears to be very similar to fistulous withers and many workers, who consider them

analogous, have studied the two conditions simultaneously, and have made composite reports of their findings. Thus, in reviewing their findings it is frequently necessary to make reference to poll evil.

Trauma

It is difficult to ascertain when trauma was first suggested as the cause of fistulous withers. However, over the span of years a great variety of injuries have been suggested as causes of the condition. Williams (1884, p. 570) taught that ill-fitting saddles caused bruises to the withers resulting in the disease, and stressed that horses with high withers were particularly liable to the injury. The condition has been attributed to many other types of injury e.g., wounds, bites, blows, rolling on stones, low stable doors, running under low tree limbs, cross bars over cattle feed racks, poorly fitted collars, improperly adjusted hames, and heavy tongued implements. Brower (1928) of the Army Veterinary Corps believed that the strain thrown upon the neck of a horse in stopping a vehicle when the brakes were not properly applied contributed substantially to producing the disease. He maintained that the army's strenuous policy of prevention along these lines held the number of cases the previous year to 22 among an average of 41,232 animals. Guard (1932) was convinced that contusion was a contributing factor and believed every precaution possible should be taken to prevent

injury to this region. Wadsworth (1916) claimed that in all the cases in which he could trace the history he considered every one of them due to a mechanical injury.

Williams (1908), Davis (1922), and Bemis (1925), doubted that very many cases of fistula resulted from injury of the withers. Williams observed that it occurred more frequently in rural horses than city horses, and that it was comparatively common in unworked, unbroken, and unstabled animals. He believed that city horses were more subject to trauma of the withers than rural horses, and that unworked, unbroken and unstabled animals would be least subject to injury of the withers; therefore, trauma could not be correlated with the occurrence of the condition. Davis also observed that it occurred much more frequently in agricultural horses than in city horses. Bemis was inclined to believe that focal infection in other parts of the body was carried to the withers by the circulation.

Filariasis of the Ligamentum Nuchae

The observation by Bovett (1861) of a filaria in a piece of ligamentum nuchae removed in an operation on a fistulous withers failed to suggest that the parasite might play any part in the disease process. Nearly 50 years later Railliet (1910) named and described the filaria found in the ligamentum nuchae in a report made to the French Society of Biology.

Robson (1918) in Australia was the first to suggest that the filaria Onchocerca cervicalis was responsible for fistulous

withers. He reasoned that a great many horses infected with this filarial parasite recovered naturally, but occasionally during heavy infestations, the inflammation was so severe that a fistula developed.

Van Volkenberg (1920-1921) examined the ligaments from 68 horses and found a parasite belonging to the Filariidae in 22 of the ligaments. He conjectured that since so few of the horses infected with the parasite had fistulous withers, the parasites must have a life cycle involving some other exit from the body than the discharge of fistulous withers, and suggested the digestive tract or some insect vector. Fifty-four percent of the ligaments he dissected had calcified areas in them and pieces of the cuticle of disintegrating parasites could be observed in many of these processes. He believed that the parasites were related to calcification in the ligament.

Casliok (1921-1922) studied 26 ligaments and found 24 of them infected with parasites at the withers and 16 infected throughout their entire length.

Hall (1923) called attention to the fact that worms of the genus Onchocerca commonly caused pathological conditions. Those listed were: O. volvulus, which causes fibrous tumors in man in Africa; O. gibsoni, which causes nodules to occur especially on the brisket and flanks in cattle and zebu in Australia, India, Ceylon, the Malay region and Southern Africa (Monnig, 1938, p. 247); and O. reticulata, which causes hypertrophy of the tendons and suspensory ligaments of the fetlock in the horse.

Ackert (1930) examined the ligaments from 12 horses and found filaria in 10 of them. Only four of the horses had fistulous withers. He observed that the living filariae were always found a little distance from the area of the ligamentum nuchae suffering the greatest pathological change. The average dimension of the males was determined to be 9.5 cm. by .152 mm. and the females was 30 cm. by .233 mm. He suspected that mosquitoes, blackflies and tabanids might be transmitters of the filariae.

The presence of O. cervicalis in Great Britain was recorded by Pillers (1931).

The life cycle of O. volvulus was worked out by Blacklock (1926). He discovered that the gnat Simulium damnosum was the intermediate host. This gave strong support to the suspicion that an insect vector was associated with the transmission of O. cervicalis from one horse to another.

Finally, Steward (1932) worked out the life cycle of O. cervicalis. It was known to be ovaviviparous so an intensive search of the blood, pus and skin of horses was made for the microfilaria. The skin was found to be the normal habitat. Since the genus Simulium has already been shown to transmit O. volvulus, attention was concentrated on this insect. However, dissection of large numbers of Simulium gave negative results. It was finally discovered that the midges of the genus Culicoides were picking up the microfilariae from infected horses. Development of the embryo worms in Culicoides nubeculosus required 24 days. Of 53 horses affected with

fistulous withers 38 were shown to harbor O. cervicalis (Steward 1935).

Steward (1932) made an unsuccessful attempt to artificially reproduce a case of fistulous withers by inoculating a horse, known to be infected with O. cervicalis, with Brucella abortus. The horse developed a high blood titer for brucellosis but failed to develop fistulous withers.

These observations leave the role of O. cervicalis in fistulous withers in a doubtful status. The finding of the parasite throughout the length of the ligamentum nuchae in animals showing no evidence of fistulous withers makes it difficult to associate the filaria with fistulous withers.

Bacteriology of Fistulous Withers

An early bacteriological search for the cause of fistulous withers was recorded by Gay (1900). From seven cases of fistulous withers he isolated a streptococcus, a yellow and a white micrococcus. Five of the seven cases were unopened when examined and of those five, three contained a sterile exudate. Bemis (1925) and Dykstra (1923) also found that a majority of their cases of fistulous withers were sterile up to the time of perforation.

Brucella abortus. In 1928 two French workers announced they had isolated Brucella abortus from two cases of fistulous withers by guinea pig inoculation. This announcement stimulated observers in many countries to further investigations of

brucellosis in equines.

Fitch and his associates (1930) found 37 horses with fistulous withers reacting positively to the agglutination test for brucellosis. They isolated Bang's bacillus in three out of nine specimens of pus. In a later report (1932) they found 48 of 61 cases of fistulous withers and poll evil reacting at titers of 1/100 or above and they succeeded in isolating Br. abortus in 7 out of 31 specimens of pus.

Hoeden (1930) in Holland examined the blood of 425 horses and found 130 reacting to the agglutination test at 1/50 or above. Of 19 cases of fistulous lesions of the neck 19 positive reactions were obtained. Br. abortus was isolated from 12 samples of pus.

Bennetts and Filmer (1931) in Western Australia reported two cases of fistulous withers agglutinating at 1/100 and 1/2000 respectively.

In Sweden, Hulthen (1931) recorded the isolation of Br. abortus from a horse with an unopened fistulous withers, and Magnusson (1932) isolated Br. abortus from two out of four cases of fistulous withers.

Duff (1933) in Scotland reported the isolation of Br. abortus from a case of fistulous withers. This stimulated his interest in the disease and in the next three years he (1936, 1937) examined 73 samples of material from unopened cases of fistulous withers and was able to isolate the organism from 60 of the samples. He emphasized that 92 percent of these horses had been in contact with cattle and 56 came from

farms known to be infected with contagious abortion.

Priestly (1934) demonstrated that the agglutination titer of normal horses was somewhat variable. He estimated that 5-15 percent of the horses of Great Britain had specific Brucella antibodies in their blood.

Poelma and associates (1933) tested the blood of a number of domestic animals in Maryland for brucellosis and of 228 horses tested, 24 were positive.

Deem (1937) found that 28 of 34 cases of fistulous withers or poll evil reacted positively, and was able to recover the organism in 9 of 15 cases that were unopened when presented for treatment at the Ohio clinic.

Stone (1938) tested the sera of 1,172 town horses of which 9.6 percent were positive at 1/50, and 205 country horses of which 23.9 percent reacted at the same dilution. Later (1941) he reported the recovery of Br. abortus from 11 of 14 horses with unopened fistulous withers or poll evil.

Taylor (1939) recorded the results of the examination of 957 sera from horses in Scotland with 40 agglutinating at 1/20 or more. He suggested that the wide divergence in the results obtained by workers in different parts of the world, might be accounted for in part by variation in the antigens used, and in part by variation in the degree of exposure to natural infection.

Fitch (1932) and Magnusson (1932), working independently, attempted to artificially reproduce cases of fistulous withers by administration of Br. abortus through various routes. Fitch

used five horses, injecting two intravenously, injecting one at the poll, inoculating one in the conjunctiva, and feeding one via mouth. Blood titers of 1/500 developed in the horse inoculated in the conjunctiva and the one receiving the bacillus by mouth; however, the organism was not recovered in either case. An abscess did develop in the horse injected at the poll and the organism was reisolated. Magnusson infected nine horses in the conjunctiva, but failed to have fistulous withers develop in any of them.

White (1935) reported a case with circumstantial evidence which indicated that a horse reacting positively to the agglutination test had infected a dairy herd.

Fitch (1939) studied the possibility of horses as a reservoir of brucellosis for cattle. He selected 80 farms having brucellosis infected cattle. Half of the farms had infected horses with titers of 1/250 or higher and half of the farms had horses negative at 1/25. Over a period of time 19 of the herds with infected horses became negative while 21 remained infected while in the same period 28 of the herds with negative horses became brucellosis free while 12 remained infected. His percentages would indicate that the positive horse does spread infection to cattle. He also reported a case of a clean herd of cattle developing Brucella infection following the addition of two reacting horses to the farms.

Karlson (1940) studied five cases of brucellosis in horses without clinical symptoms. Each horse was destroyed after several months observation and the testes, epididymes, lymph

nodes of the alimentary tract, spleen, liver, bone marrow, kidneys, and synovial fluid from tendon sheaths and joints were examined for Br. abortus. Two horses developed fistulous withers during the study and Br. abortus was isolated from one. Br. abortus was isolated from the feces of two horses. Lesions in the sternum of a fourth horse and in the ribs of a fifth yielded Br. abortus. The observation that Br. abortus may be eliminated with the feces in infected horses leads again to the conclusion that positive animals may be a source of infection for cattle.

Other localized lesions of Br. abortus in equines have been described. McNutt (1924) reported an abortion in a mare from which Br. abortus was isolated. Frost et al. (1938) isolated Br. abortus from a case of gonitis of the stifle joint in a horse. They reported that the fluid agglutinated at 1/800.

Deem (1937) studied the length of time that Br. abortus was discharged after lancing an unopened case of fistulous withers. He was unable to recover the bacillus from any of five cases of fistulous withers examined from one to six weeks after being opened.

These reports indicate quite conclusively that Br. abortus is definitely associated with fistulous withers and that the horse must be considered a potential source of brucellosis infection.

Actinomyces bovis. Kimball and Frank (1945) were the first to report a successful search for anaerobic micro-organisms. They isolated Actinomyces bovis from 40 of 50 cases of unopened

fistulous withers and 5 cases of poll evil by inoculating media with curettements of the involved tissues. They indicated that a large number of inoculations of culture media were necessary for satisfactory isolations. However, in examining the exudate, they did not observe the club-bearing rosettes or "sulfur granules" that characterize actinomycotic pus (Hagan 1945, p. 324).

This discovery probably explains the reason for the successful results reported (Butler 1940) in the treatment of fistulous withers with sodium iodide administered intravenously. It, also, appears to be directly related with the pathology of the tissues herein described.

ANATOMY OF THE WITHERS

The withers is the dorsal prominence between the shoulder blades of an equine. It is formed by the extremely long spinous processes particularly of the third, fourth, and fifth thoracic vertebrae. Above the spines, extending from the occiput to the supraspinous ligament, is the ligamentum nuchae, a powerful elastic apparatus, the principal function of which is to support the head and neck. At the withers it broadens greatly, forming an expansion about five to six inches in width, the lateral margins of which are thin and turn down over the trapezius muscle. According to Sisson (1935, p. 213) the ligamentum nuchae consists of two parts; namely, funicular and lamellar. The funicular part attaches to the external occipital

Fig. 1. Ligamentum nuchae of horse.

1, lamellar part; 2, funicular part; 3, expansion at the withers; 4, scapular cartilage; 5, spine of scapula; 6, first thoracic vertebra. (After Sisson 1935.)

protuberance, anteriorly, and is largely continuous with the lumbo-dorsal part of the supraspinous ligament, posteriorly. At the point where the change from elastic to collagenous fibers takes place, there is attachment to the spinous processes. The funicular part is composed of right and left halves from the level of the second thoracic spine anteriorly to the middle of the neck. The lamellar part consists of two laminae separated medially by a layer of loose connective tissue. Each lamina is formed of digitations which attach to the second thoracic spine and the funicular part, and which are directed downward and forward to end on all, except the first and last spines of the cervical vertebrae. Interposed between the ligamentum nuchae and the thoracic spines is the supraspinous bursa.

The bursa usually covers the summits of two spines. It is commonly over the second and third spinous processes but may extend backward as a unit. Thus, it may be above the third and fourth or even the fourth and fifth spines. It is not limited to the summits of the spines but may extend laterally a variable distance between the trapezius and rhomboideus muscles. It may even reach the border of the scapular cartilage. It also may pouch a slight distance dorsally between the halves of funicular part of the ligamentum nuchae.

The muscles of this region may be divided into superficial and deep layers. The superficial layer consists of the trapezius and latissimus dorsi. The trapezius is a large thin triangular shaped muscle having distinct cervical and

Fig. 2. Superficial muscles of the withers.

1, splenius; 2, serratus cervicis; 3, trapezius cervicalis; 4, trapezius thoracalis; 5, latissimus dorsi. (After Sisson 1935.)

thoracic portions. It originates from the deep surface of the funicular part of the ligamentum nuchae and the supraspinous ligament extending from the second cervical to the tenth thoracic vertebrae. The cervical portion inserts on the spine of the scapula while the thoracic part inserts on the tuber spinae of the scapula.

The latissimus dorsi originates from the lumbo-dorsal fascia and by this means extends from the high point of the withers to lumbar region. It lies partly under the trapezius thoracalis. The place of insertion is the teres tubercle of the humerous.

The deep layer is made with the rhomboideus, splenius, serratus cervicis, longissimus dorsi, and spinalis. The rhomboideus, like the trapezius, is composed of cervical and thoracic parts. The cervical part originates from the funicular part of the ligamentum nuchae extending from the second cervical vertebra to the second thoracic vertebra. The thoracic part originates from the spinous processes of the second to the seventh thoracic vertebra. The muscle inserts on the medial surface of the cartilage of the scapula.

The splenius originates under the rhomboideus from the second, third, and fourth thoracic spines and extends parallel to the ligamentum nuchae to insert on the nuchal crest, the mastoid process, the wing of the atlas, and the transverse processes of the third, fourth, and fifth cervical vertebrae.

The serratus cervicis is actually the cervical part of the serratus ventralis. Its origin is the transverse processes

Fig. 3. Deeper muscles of withers.

1, serratus cervicis; 2, rhomboideus; 3, spinalis dorsi; 4, longissimus dorsi; 5, supraspinatus; 6, infraspinatus; 7, serratus thoracis. (After Sisson 1935.)

of the last four or five cervical vertebrae and it inserts on the antero-dorsal (facies serrata) part of the medial surface of the scapula and scapular cartilage.

The longissimus dorsi is the longest and largest muscle in the body. It extends from the sacrum and ilium to the middle of the neck, filling up the space between the spinous processes medially and the lumbar transverse processes and the upper ends of the ribs ventrally. The spinalis is actually a part of the longissimus dorsi.

At the withers the lumbo-dorsal fascia forms an important structure, the dorso-scapular ligament. This is a strong tendinous sheet, attached to the third, fourth, and fifth thoracic spines. Its upper part is very thick and gives origin by its superficial surface to the rhomboideus thoracalis; by its anterior part to the splenius. The lower part is thin and elastic and furnishes numerous lamellae.

THE GROSS PATHOLOGY OF TEN CLINICAL CASES OF FISTULOUS WITHERS

In order to study the gross structure and alterations that occur in fistulous withers 10 horses with typical unopened clinical symptoms were destroyed, and the region of the withers carefully dissected. The gross anatomical alterations were observed and recorded for each case. The following case descriptions contain the pertinent pathology of each case.

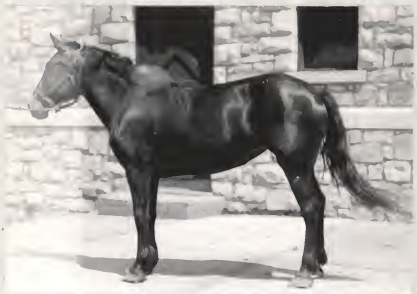

Fig. 4. The clinical appearance of a case of fistulous withers.

Case 1. The ante mortem appearance was that of a large unilateral fluctuating swelling on the left side measuring irregularly 8 inches in height and 20 inches in length. The skin was not adherent to it. After euthanasia the sac enclosing the exudate was exposed by reflexing the skin and trapezius muscle downward from the withers. The sac extended posteriorly under the anterior border of the latissimus dorsi muscle, and ventrally between the trapezius muscle and the scapula to the tuber spinae. The medial aspect of the sac was readily dissected from the underlying rhomboideus and serratus cervicalis muscles and the lateral side of the cartilage of the scapula but was firmly attached to the dorsal border of the cartilage of the scapula. The ligamentum nuchae,

over the bursa, was necrotic with some calcification. The supraspinous bursa was not connected with the fistulous sac, but was enlarged, extending from the third to sixth spinous process, and seemed to have a sacculation on the left side. There was some periostitis of the spinous processes under the diseased ligament.

When the fistulous sac was opened, it contained a large amount of serous exudate in which there were large fibrinous clots. Considerable fibrin was adherent to the wall of the sac.

Case 2. Clinically, this case had a swelling about eight inches in diameter beginning high on the left side of the neck just anterior to the spine of the scapula, and extending ventrally to the level of the tuber spinae of the scapula. The spinous processes of the second, third, fourth, and fifth vertebrae were palpable. Apparently the median portion of the ligamentum nuchae was destroyed or greatly thinned.

At dissection the swelling, or fistulous sac, was covered laterally by the trapezius cervicalis muscle and extended upon the rhomboideus cervicalis, serratus cervicis and supraspinatus muscles. Its medial surface was firmly attached to these latter three muscles and the anterior border of the scapular cartilage. The cartilage was roughened indicating the existence of a perichondritis sometime during the course of the disease. The dorsal border of the fistulous sac did not extend under the ligament. Removal of the ligament failed to display the supraspinous bursa. Only a very small pocket of bursal-like tissue existed over the third spinous process. The area of the ligament

where the spinous processes were palpable was thinned and was calcified to the extent that it could not be cut with a knife.

The fistulous sac consisted of dense connective tissue. The sac was filled with a fibrino-necrotic exudate. It consisted of three separate communicating sacculations.

Case 3. This case exhibited bilateral swellings. Post mortem examination disclosed that the fistulous sac on the left side originated under the edge of the ligamentum nuchae at the withers and extended laterally under both parts of the trapezius muscle a distance of 3-1/2 inches. The antero-posterior length of the sac was about 15 inches. It extended from the sixth cervical vertebra to the sixth thoracic vertebra. It was attached to the underlying rhomboideus muscle.

The right sac lay subcutaneously on both parts of the trapezius muscle. This was an extensive swelling measuring about 13 inches in length and 8 inches in width. It was quite dorsal in location and its highest point extended about 5-1/2 inches from the normal surface of the withers. It originated under the ligamentum nuchae causing the ligament to be raised from the spinous processes. However, the spinous processes of the vertebrae were not involved by the inflammation and the sac was dissected completely away from the processes.

The exudate of this case was a serous fluid containing necrotic tissue and clots of fibrin.

Case 4. This horse presented a large subcutaneous swelling at the point of the withers measuring 14 inches in length and 8 inches in height. At dissection, the sac was firmly attached to the ligamentum nuchae. A small isolated pocket had developed between the second and third spinous processes and between the lamellar layers of the ligamentum nuchae that was not connected with the large sac.

On opening the main sac it was discovered that the ligamentum nuchae had become completely separated and the two necrotic ends were embedded in the anterior and posterior walls of the sac. They were about 6 inches apart. There was no inflammation of the spinous processes.

The exudate was of the same serous nature with clots of fibrin in it as in the preceding cases.

Case 5. This case had bilateral swellings. Dissection of the right side revealed a subcutaneous sac 2-1/2 inches in diameter which lay over the anterior angle of the scapula. A deep pocket protruded under the rhomboideus muscle from between the lamellar parts of the ligamentum nuchae anterior to the second thoracic vertebra.

The left sac had two subcutaneous pockets which were attached to the lateral margin of the ligament. About six inches of the ligament had been replaced with white fibrous tissue. Sinus like pockets of pus were located under the ligamentum nuchae at each end of the fibrotic area. The supraspinous bursa was replaced by connective tissue but no decalcification of the spinous processes had occurred.

The exudate of the lateral subcutaneous sacs was the characteristic semi-transparent yellow fluid containing clots of fibrin.

Case 6. This was another case with bilateral involvement. The sac on the right side originated under the edge of the ligamentum nuchae and descended between the trapezius and rhomboideus muscles. There were several pouching fistulous tracts. The sac on the left side was similar except that it had penetrated the trapezius muscle at one place, and established a communicating subcutaneous sac over the trapezius muscle. The ligamentum nuchae was necrotic and fibrosed from the third to the fifth spinous process. The underlying spinous processes were not involved.

Case 7. The post mortem dissection of this horse displayed a dorsal bilateral sacculated swelling originating from the dorsal aspect of the ligamentum nuchae and gravitating superficially over the trapezius muscles on both sides. The swelling consisted of a series of intercommunicating cavities filled with semisolid necrotic material with a serous fluid. The ligament was embedded in the granulomatous mass. This mass was attached by fibrous tissue to the spinous processes of the second to sixth thoracic vertebrae. Two of the vertebral spines, on splitting, showed distinct areas of necrosis and decalcification.

Case 8. This case consisted of a large subcutaneous swelling dorsal to the ligamentum nuchae and somewhat on the right side of the withers and an extensive flat swelling

on the left side. The dissected left sac passed ventrally between the trapezius and rhomboideus muscles and medial to the anterior border of the scapula and the serratus cervicis muscle. Dorsally the sac extended under the ligamentum nuchae. It was filled with a thick purulent exudate. The spinous processes were not invaded by the disease process.

Case 9. This case was that of a mule with a unilateral swelling on the left side of the withers. The dissected sac was 8 inches in diameter and lay anterior to the spine of the scapula, dorsal to the tuber spinae, and under the trapezius cervicalis muscle. It communicated directly with the supraspinous bursa. There was a small sac pouching out on the right side under the ligament which communicated through a small sinus with the supraspinous bursa. The infectious process also had started to burrow posteriorly under the ligament. There was no involvement of the ligamentum nuchae or the spinous processes. The sac was filled with the typical serous fluid containing fibrino-necrotic clots.

Case 10. This horse had a soft fluctuating swelling at the point of the withers. After removal of the skin, it was found to lay principally under the dorsal surface of the ligamentum nuchae. It was approximately 12 inches in length, 10 inches in width and 4 inches in depth. It was firmly attached to the ligament and extended over the fascia and trapezius muscles on both sides of the animal. A fistulous tract connected the dorsal sac with an inconspicuous right lateral sac anterior to the second spinous process. This lateral sac lay beneath

the trapezius muscle and was adherent to the rhomboideus muscle. It was not discernible until the trapezius muscle was dissected away. It measured about 8 inches in length. There was some necrosis of the ligamentum nuchae but no calcification was observed.

The sacs were filled with yellow fluid containing the usual fibrino-necrotic clots.

There has been some variation of opinion as to the anatomical structure initially involved in fistulous withers. Williams (1908, 1913-1914) believed that the disease began in a space he termed the fenestrum, located between the cordiform and lamellar portions of the ligament anterior to the summit of the second thoracic spinous process. Dykstra (1923) and Bemis (1925) both described fistulous withers as a supraspinous bursitis. Frost (1935), also, found that the bursa was involved in 40 of 42 cases of fistulous withers presented at the Cornell Veterinary Clinic. The study of these ten cases bear out the observations that fistulous withers is an inflammation of the supraspinous bursa.

It appears that as the exudate accumulates in the bursa, the bursal walls are distended and by fibroblastic proliferation the fistulous sacs are formed. The fistulous sac, thus formed, is actually the greatly distended bursa. It should be noted that the bursa is distended mainly by two routes. One is laterally under the edge of the ligament, generally between the trapezius and rhomboideus muscles and the other is dorsally between the two halves of the funicular portion

of the ligamentum nuchae. Apparently the direction in which the fistulous sacs develop is influenced by the shape of the bursa prior to infection. Bursae with extensive lateral pouches probably distend laterally, while those with a well developed dorsal pouch distend dorsally between the funicular portions of the ligamentum nuchae.

It will be noted that one case (No. 8) had both dorsal and lateral sacs; three cases (Nos. 3, 5, and 6) had bilateral sacs; three cases (Nos. 1, 2, and 9) unilateral sacs; and three cases (Nos. 4, 7, and 10) dorsal sacs only. It is believed that as the exudate accumulates, the distension of the lateral diverticuli permits the bursae to pouch from under the ligament. Case 3 illustrates that the bursa is loosely attached to the ligament and spinous processes. It should be noted that the right sac was readily dissected free from the ligament and spinous processes. It also points out that the fistulous sac and the bursa are analogous.

The ligamentum nuchae shows involvement in seven of these cases. It is a structure with very poor nutrition and this explains why it suffers so severly when involved by the disease process. In case 4, a portion of it had undergone complete necrosis but the ends evidently had previously become embedded in the fibrous walls of the fistulous sac. In several of the other cases it has been replaced with white fibrous tissue. Gross areas of calcification in the ligamentum nuchae over the supraspinous bursa were present in two cases. Van Volkenberg (1920-1921) and Ackert (1930) were of the opinion that calci-

fication in the ligament was caused by infection of long duration by Onchocerca cervicalis.

The spinous processes were infected in only one case.

The appearance of the exudate of fistulous withers is another constant feature. It regularly consists of a yellow somewhat cloudy liquid containing clots of fibrin and various amounts of necrotic debris. The purulent exudate of case 8 probably indicates that the fistulous sac had ruptured sometime previously and invading aerobic organisms had set up a purulent inflammation.

From the foregoing descriptions fistulous withers may be defined as, a chronic infectious inflammatory process of equines arising in the supraspinous bursa. It is composed of a sero-fibrinous exudate enclosed in a thick fibrotic sac. The process seeks an exit by distention of the bursal wall through the tissues that are most easily penetrated, and it may rupture through the skin at any point of the withers, thus forming fistulas, hence the name fistulous withers.

HISTOPATHOLOGY OF FISTULOUS WITHERS

To start this study, histological sections were prepared from what appeared grossly to be a normal supraspinous bursal wall. These sections indicated that the wall normally consists of areolar connective tissue and is lined with a single layer of very flat probably endothelial cells.

The pathological tissues studied were representative pieces

of the walls of the fistulous sacs, various portions of the ligamenti nuchae, and the infected spinous processes of the one case where the spinous processes were infected.

The pathology of these infected tissues proved to be surprisingly constant. The proliferation of connective tissue infiltrated with the cells prominent in inflammations constituted the basic pathological tissue arrangement in every case. The plasma cell was the most conspicuous of all cells particularly in the inner walls of the fistulous sacs. Along with the plasma cells were lymphocytes, the group of cells generally referred to as mononuclear phagocytes (Runnells, 1946, p. 145) and scattered polymorphonuclear neutrophiles. The walls of the fistulous sac were constantly arranged this way. Scattered areas of necrosis within the walls indicated the progressive character of the inflammation. In 50 percent of the cases multinucleated giant-cells of Langhan's type were scattered among the other inflammatory cells. In areas of active proliferation of fibroblasts, vascularization was prominent. In general the fistulous sacs were lined with fibrin and small numbers of necrotic cells. In case 8 the purulent nature of the exudate was in evidence in the section; however, the cellular components within the sac wall were the same as in the other cases.

Three types of changes were observed in the sections of the ligamentum nuchae, namely, necrosis, fibrosis, and calcification. Degeneration began by fragmentation of the coarse

fibers of the ligament followed by coagulation necrosis of a large area of the ligament or by fibrosis. If the latter occurred, the fibroblasts proliferated between the broken fibers of the ligament accompanied by vascularization. Small numbers of lymphocytes frequently collected perivascularly indicating the chronic inflammatory nature of the process. In 50 percent of the ligaments pieces of cuticle of the filaria Onchocerca cervicalis could be seen. However, evidence indicating that the parasites were primary in the inflammatory reaction in the ligament was lacking. Areas were observed where the worms had become entrapped, so to speak, in the inflammation but in general they seemed to incite little or no tissue reaction. Most of the parasites were surrounded by a capsule of dense white fibers. Where there was an inflammatory reaction about a filaria, lymphocytes and eosinophilic leucocytes infiltrated the inflammatory zone. Areas of calcification in the ligamentum nuchae appeared independent of the parasites in all of the sections. It is possible, however, that the parasites may have caused the deposition of calcium salts in the ligament and as this progressed they moved away from the area. This seems to be a likely explanation as areas of calcification are frequently observed in ligaments of horses that do not have fistulous withers.

The infection in the spinous processes occupied the marrow spaces causing decalcification of the bone lamellae and periosteal proliferation.

BRUCELLOSIS IN HORSES PRESENTED AT KANSAS STATE VETERINARY CLINIC

During the course of this study as many of the horses presented at the clinic, as was practicable, were tested for brucellosis. Blood samples were taken from each horse and the serum allowed to collect. Then by the rapid plate method of the Bureau of Animal Industry, using standard commercial antigen, the sera were tested in dilutions of 1/25, 1/50, 1/100, 1/200 and 1/400.

A total of 59 horses were tested. Eleven of these were clinical cases of fistulous withers. The remainder were presented for other conditions. All of the horses with fistulous withers reacted positively to the agglutination test at a dilution of 1/50 or above. Of the other 48 horses tested only 5 reacted at 1/50 or above.

DISCUSSION

The evidence presented by a review of the literature suggests that Brucella abortus is a significant etiological agent in fistulous withers. It is doubtful that Onchocerca cervicalis is associated with the process. This study of the microscopic components of the pathological tissues attaches more importance to the isolation of Actinomyces bovis than to the previous agents. Although the formation of rays and clubs or rosettes ordinarily attributed to Act. bovis were not observed in the sections, the thick fibroblastic sacs in-

filtrated with plasma cells, lymphocytes, and mononuclear phogocytes certainly resemble more closely the lesion of actinomycosis than either brucellosis or filariasis. The filaria apparently is a parasite of the ligamentum nuchae and its appearance with fistulous withers is coincidental. All of the evidence presented by the literature and the results of blood tests made on cases of fistulous withers at the Kansas State Veterinary Clinic certainly associate Br. abortus with fistulous withers.

The typing (Plastridge 1931) of four isolations of Br. abortus of equine origin and the discovery that they were the bovine strain; the observation (Williams 1908, Davis 1922) that fistulous withers occurred more frequently in country horses than in city horses; the report of Duff (1936) that 92 percent of his cases had been in contact with cattle and 56 cases came from farms known to be infected with contagious abortion, all suggest that the cow infected with Br. abortus must be the source of the infection for the horse. The experiments of Magnusson (1932) and Fitch (1932) indicate that a horse may become infected with Br. abortus without developing fistulous withers. It may be that horses with fistulous withers, not presenting a history of contact with cattle, developed a positive blood titer previously, when associated with cattle, and came down with fistulous withers only after a long period of latent infection.

The cases reported by Hulthen (1931), White (1935) and Fitch (1939) certainly indicate that horses with positive blood titers may be a source of brucellosis infection for cattle.

Since Act. bovis and Br. abortus are primarily infectious organisms of cattle, it would appear that a bovine with either infection must be a hazard to equine husbandry.

The pathology of brucellosis in fistulous withers is at present limited, however, to the isolation of Br. abortus from the exudate and the demonstration of agglutinins specific for Brucella in the blood serum and serous portion of the exudate (Duff 1936).

Just how Br. abortus and Act. bovis gain entrance to the supraspinous bursa is at present a matter for conjecture and must be left for future investigations.

CONCLUSIONS

1. Fistulous withers is a chronic inflammatory process originating in the supraspinous bursa and extending, either dorsally between the funicular portions of the ligamentum nuchae, or laterally under the border of the ligament, by fibroblastic proliferation of the bursal wall.

2. When the infected bursa extends dorsally, the ligamentum nuchae overlying the bursa may be completely destroyed by necrosis, or replaced by fibrous connective tissue.

3. The cellular components of the inflammatory tissue of the walls of the fistulous sacs resemble closely those found in lesions produced by Actinomyces bovis.

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A B S T R A C T

THE PATHOLOGY OF EQUINE FISTULOUS WITHERS

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This study deals primarily with the gross and microscopic pathology of the lesions of fistulous withers and the possible relation to the etiological agents that have been found by other investigators. The data presented is based on the study of equine material collected in the School of Veterinary Medicine over a period of approximately two years and includes the gross pathology of 10 clinical cases of fistulous withers. In every case representative pieces of the involved tissues were prepared for microscopic examination. In addition, a study was made of the incidence of brucellosis in equines presented at the veterinary clinic having fistulous withers, as compared with those presented for other conditions.

In the review of the literature, it is shown that the biological agents that have been associated with fistulous withers are the filaria, Onchocerca cervicalis, and the bacteria, Brucella abortus and Actinomyces bovis. Also, it is shown that traumatizations of the withers have long been considered by many veterinarians as playing a contributing role in fistulous withers.

A total of 59 horses were tested for brucellosis. Eleven of these were clinical cases of fistulous withers. The remainder were presented for other conditions. All of the horses

with fistulous withers reacted positively to the agglutination test at a dilution of 1/50 or above. Of the other 48 horses tested, only 5 reacted at 1/50 or above.

It is pointed out that the pathology of Br. abortus in fistulous withers is limited to the reports of isolation of the organism from unopened cases and many of these reports also indicate that the horse is infected by cattle with brucellosis. Cases of horses with brucellosis infecting cattle have also been recorded.

From the study of the gross pathology, the conclusion is made that fistulous withers is a chronic inflammatory process originating in the supraspinous bursa and extending, either dorsally between the funicular portions of the ligamentum nuchae, or laterally under the border of the ligament, by fibroblastic proliferation of the bursal wall. When the infected bursa extends dorsally, the ligamentum nuchae overlying the bursa may be completely destroyed by necrosis, or replaced by fibrous connective tissues.

The microscopic study of the sectioned tissues disclosed that the cellular components of the inflammatory tissue of the walls of the fistulous sacs resemble those found in lesions produced by Act. bovis.

The filaria was believed to be entirely a parasite of the ligamentum nuchae and its appearance with fistulous withers coincidental.