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EDITOR'S NOTE: The length of the original paper made it necessary to edit it for inclusion in *The Fan Hitch*. Therefore readers are reminded that some data, statements in support of conclusions drawn, along with the list of references, are not a part of what is presented below. Nevertheless, this scientific paper offers insight into the invaluable contribution of both the authors and the dogs. *The Fan Hitch* expresses its profound gratitude to A.R.M. Bellars for sharing this research with its readers. This paper is reproduced here by permission of the Natural Environment Research Council (the parent body of the British Antarctic Survey) who holds sole copyright. We are indebted to them for allowing us to share it with you.

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Veterinary Studies on the British Antarctic Survey's Sledge Dogs: II. Occupational Osteoarthritis

by A.R.M. Bellars and M. F. Godsal

ABSTRACT

The results of the investigaiton into the problem of osteoarthritis in British Antarctic Survey sledge dogs are presented. Clinical, pathological and radiographical findings are described. The aetiology of the condition which shortens the working life of the majority of these dogs is discussed. The present evidence suggests that the pressure due to pulling loaded sledges is the main factor causing acceleration of the degenerative changes due to ageing, and movement, of the main limb joints. No evidence was found of an hereditary basis for the condition. Dog-team drivers of the British Antarctic Survey have come to accept the fact that otherwise healthy Antarctic sledge dogs are usually incapable of further work by the time they are 8 years old. Since this is less than might be expected of a dog of the husky's size and weight under normal conditions, an investigation in to the possible causes of the decline of the ageing husky was started in 1963-1964.

This paper is intended to show the results of the investigaiton, undertaken during two austral summer tours of the survey's stations by the authors in 1963-64 (M.F.G.) and 1967-68 (A.R.M.B.)

Radiographs of littersisters Tiriganiaq (top) and Amaruq (bottom) taken at approximately 5 years of age. Both dogs were received in 1994 from a working team in Pond Inlet, NT at the age of 3.5 years. Normal hip conformation.

HISTORY

In 1963-64 Godsal examined all the dogs at the stations, and destroyed 34 of them. Most of these dogs were incapable of further work, but some were destroyed because they were surplus to requirements. The main finding on post-mortem examination was erosions of the articular cartilage of the hip and shoulder joints. The results of this study led to the conclusion that no satisfactory hypothesis of the aetiology of the condition could be reached unless poor conformation of the affected joints was eliminated as a causal factor. Hip dysplasia, a disease thought to be hereditary, and known to affect certain breeds such as the Alsation, Cocker Spaniel, Labrador Retriever and Alaskan Malamute, often gives rise to severe osteoarthritis of the hip. The condition is usually diagnosed by radiological examination of the hip, so that, although there was no other clinical evidence of hip dysplasia apart from the erosions, a portable x-ray unit was taken to Stonington Island in 1967-68. 29 Antarctic sledge dogs underwent radiological examination. In addition, slow-motion cine film was made of the dogs drawing a sledge to see if the unusual gait of the working husky might in itself be a factor in the slowing of the ageing dogs.

This paper also shows that osteoarthiris is the reason for the destruction for nearly 72 per cent of males and 52 per cent of females that survive beyond 5 years of age, excluding deaths due to accidents.

METHODS

Age (yr.)	*Number of dogs*
2	1
3	1
4	0
5	4
6	6
7	6
8	6
9	5
10	3
11	2
	34

TABLE I: AGE DISTRIBUTION OF GRAHAM LAND SLEDGE DOGS DESTROYED IN 1963-64

1967-68

Twenty-five adult sledge dogs and two pups were selected for radiography of pelvis and hips. Those selected were in three groups:

i. Aged less than 18 months
ii. Aged more than 6 years
iii. Three dogs of intermediate age, showing signs of premature "ageing".

All other dogs between 18 months and 6 years were regarded as being in their prime and sound, and thus unlikely to reveal abnormalities.

The dogs tolerated being on their backs without sedation, and a satisfactory series of ventro-dorsal pictures was obtained.

Slow motion cine film was taken from the side, front and rear of a working team of sledge dogs. The results were analysed to see if the gait of the working husky could predispose to erosions of hip and shoulder articular cartilage.

RESULTS

Clinical findings The clinical signs associated with this condition in these dogs were not dramatic. It had been generally accepted that most Antarctic sledge dogs were too old for normal work at 7-8 years, so some drivers did not notice anything that they considered was abnormal. It was possible to establish, however, that certain dogs were becoming progressively slower than their team mates, and this slowing-up was by far the commonest complaint of drivers. Actual lameness was not widespread, probably because the condition was insidious in onset and almost invariably bilateral. In advanced cases, muscle wasting was apparent about the affected joints and it was usually pronounced about the hips and pelvis. Some dogs appeared to walk stiffly with their backs arched, especially after a period of rest. Pain could be elicited when the hips and the shoulders were flexed; full flexion of all the forelimb joints occurs every time the dog is put into the close-fitting harness. In no case were the joints themselves swollen or painful. In one very advanced case, the dog cried out with almost every stride of his forelegs but showed no signs of not wanting to work and never stopped pulling.

Some experienced drivers turned the occurrence of osteoarthritis in their team to good advantage, finding that these older dogs seem to be aware of their capabilities and settle down more quickly at the start of a day's work than the young impulsive members of the team, transmitting to them the skill in pacing-out their energies for a long haul. However, once a dog has begun to suffer clinically from osteoarthritis, it is generally found that the affected dog will not last for another full season of work.

Pathological findings In general, the older huskies were more often affected than the younger ones, but the severity of the lesions were not necessarily more marked in the older dogs, and neither was there a straightforward relationship between the severity of the lesions and the clinical symptoms.

Of the 34 dogs that were destroyed, 26 were affected. Nine of these had osteoarthritis of the hips only, three had erosions of the head of the humerus only, and in the remaining 15 affected dogs both hips and shoulders were involved. In two dogs one elbow was arthritic and in one dog both elbows showed lesions. One dog was found to have osteoarthritis in one stifle joint. The youngest affected dog was a 3.5 year-old female. Study at post-mortem examination and later showed that there was no evidence of shallowness of the acetabulum in any of the dogs examined.

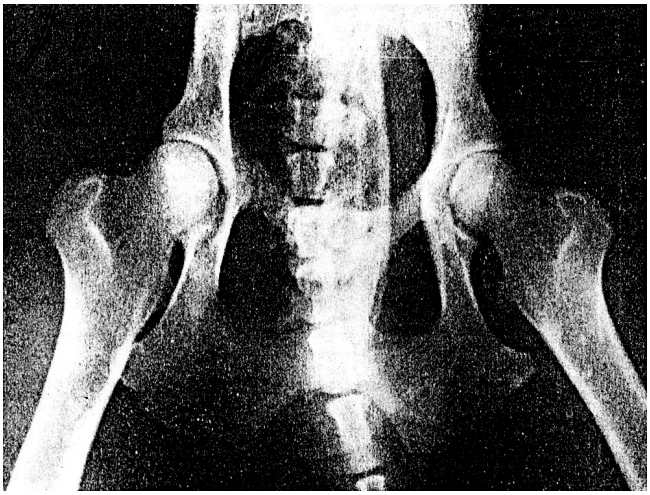
Likewise, the heads of the femora and humeri showed normal conformation.

Results show that in the British Antarctic Survey sledge dog:

i. there is an increased tendency to osteoarthritis of the hip and shoulder joints with increased age.
ii. severe cases can occur before 6 years of age.
iii. some dogs are unaffected at nearly 8 years of age.
iv. all dogs over 8 years of age were affected.
v. osteoarthritis of the hip joint is more common and occurs earlier in life than osteoarthritis of the shoulder joint.
vi. more than half of the affected dogs were affected in both hip and shoulder joints.

The post-mortem appearance of some of the joints makes it remarkable that the affected dogs were willing to pull a sledge at all.

Radiographic findings Overall the results were adequate for judgment of conformation. The hip joints showed no evidence of sufficient abnormality to be called hip dysplasia. The shoulder joints showed normal conformation.



Radiograph of hips and pelvis of 1.5 year old male sledge dog showing complete normality. (Scan of the photocopied scientific paper, not without defects in reproduction. Ed.)

Findings from the cine film The husky adopts a different gait while pulling a sledge, although when allowed to run free it will move as any other dog. By studying the slow-motion film, it is clearly seen that the working husky restricts spinal movement in the horizontal plane so that its spine is held relatively rigid. The husky also has a pronounced, stiff "waddling" movement of the hindquarters (to be distinguished from the looser “rolling” associated with hip dysplasia), and abducts its hind limbs so that its hind feet are placed wider apart than normal. The pelvis shows minimal movement in the vertical plane when each leg in turn is protracted (brought forward) as the dog leans into the harness. Since it can be assumed that the pelvis is "fixed" at the hip when the hind limb is fully weight-bearing and that the sacro-iliac junction is virtually immobile, it follows that as protraction commences there is bending of the spine away from that side and rotation of the spine about its longitudinal axis. The probable site for this rotation of the spine is high up in the thoracic region. It would appear that this combination of movements produces the peculiar gait, and also gives the dog great mechanical efficiency and purchase with which to pull for long periods. The forelimb movements, as seen on the film, are different from those of the hind limbs. The dogs appear "bandy-legged" while pulling with the forepaws placed nearer to the mid-line than would be the case in a normal standing position. Each foreleg in turn is swung outwards during protraction before the paw comes inwards to be placed on the ground. Presumably this is because dogs are incapable of more adduction of the forelimb. Thus in order to achieve easy and efficient protraction, the leg is swung outwards to assist the weak adductor muscles against the antagonism of the muscles of abduction.

DISCUSSION

The results show that osteoarthritis of the hip and shoulder joints is the cause of decline of the majority of the Survey's older sledge dogs and that hip dysplasia does not occur in a representative selection of these dogs. This discussion assesses the possible factors that may be concerned in the aetiology of the condition, particularly the normal processes of ageing, the effects of pressure on weight-bearing joints, the loads that may be taken on the joints of sledge dogs and the effects of the Antarctic environment. The discussion also refutes the argument that osteoarthritis of the hip joint of the dog should immediately lead to a tentative diagnosis of hip dysplasia.

Ageing Articular changes take place in ageing animals. The changes in the joint follow the same pattern as seen at various ages in the Antarctic Husky. Surface defects in the cartilage develop particularly in weight-bearing areas. Thus, age is considered here as a primary cause, since it is not only related to senescence of the joint tissues, but also offers the opportunity for long continued trauma. However, age alone is not responsible for changes seen in the husky. The normal life span of these dogs is not known exactly, but estimates based on dogs reared in this country and on dogs brought back from the polar regions suggest 9-13 years with an upper limit of about 15 years. The shortened life span of Antarctic dogs, some of which are quite young when clinically affected with osteoarthritis, therefore suggests a considerable degree of pathological (as opposed to physiological) degeneration. Concerning the possible contributory factors, the occurrence of osteoarthritis throughout the population, enabled us to rule out infections, hormonal disturbances, gross trauma and individual congenital or adaptatinal deformities, and our own examination of the dogs confirms this. From the predisposing factors known to lead to osteoarthritis in man and animals, abnormal conformation, special occupational activities, abnormalities of gait and changes due to nutrition are left for consideration.

Joint conformation The combined histories of 700 of the Survey's sledge dogs reveal no instances of symptoms or of the typical gait associated with hip dysplasia, i.e. "swaying" or "rolling" of the hindquarters. With only two

exceptions, osteoarthritis of the Antarctic sledge dog is not seen in the younger animals, but it occurs clinically at a peak of 7.5 years of age, often in both hip and shoulder joints. By virtue of these findings, and the conformation shown on the radiographs, we feel justified in believing that hip dysplasia, as seen in dogs in the United Kingdom, is not present in the Survey's sledge dogs.

Occupational activities A mature Antarctic husky is expected to draw more than its own bodyweight on most sledge journeys. To give an estimate of the force that may be transmitted to the main limb joints, the work by Taylor showed that the individual pull on a loaded sledge averaged 6 kg/dog for 9 minutes when measured on one occasion. This pull would be largely passed via the harness to the shoulders and hips, and the force on the joints would be greatest when the limbs were in the position of maximum thrust. This matches the post-mortem findings, which show erosions not on the surfaces opposed during normal standing, but those in opposition at extension retraction. In the working husky, the force is spread over four main limb joints but the resulting diminution of the total load on any one hip or shoulder will be reversed by the extra load due to the pull on the sledge. It is reasonable to suppose that the resultant force transmitted to the hip or shoulder of a working husky would be far greater than the 6 kg. pull measured by Taylor. Cartilage surface defects and degeneration develop especially in the areas subject to weight-bearing and movement.

Trueta and Trias have not only emphasized the effect of weight-bearing on joint degeneration but have also pointed out that osteoarthritis is brought about by interference with the vitality of the chondrocytes, and that this is commonly achieved by wrongly distributed and intermittent pressure. Although weight-bearing areas show the development of degenerative changes, the work of Harrison and others showed that the primary change in articular cartilage took place in the non-weight-bearing areas and consisted mainly of hyperplasia of the cartilage, leading to chondromalacia. Thus it may be that the occurrence of osteoarthritis depends not so much on weight-bearing on so-called normal areas but on weight-bearing on areas of joint cartilage not normally subject to pressure. This may be due to anatomical anomalies of which the Antarctic sledge dog shows no signs, or to incorrect joint function causing undo compression on part of the articular cartilage and insufficient compression on the remainder. If, as has been suggested, the Antarctic sledge dog adopts an unusual posture while pulling, this abnormal gait will induce faulty joint function. In addition, the life of the dogs is such that hard-pulling efforts alternate with "lie-up" periods of bad weather, periods when the dog drivers are working in the field away from the team, and long spells of relative idleness at the scientific station. It is probable that this alternation between extreme effort and rest is an important factor leading to articular changes.

The effects of pressure and postural changes have been implicated in the possibility of ischaemia of articular structures. Articular cartilage itself is devoid of blood vessels except in the very young and the very old. It was suggested by Walmsley that the arterial supply to the head of the femur in man was reduced with age. However Harrison and others found a copious blood supply and free anastomosis even in old age, and Roberts found no evidence to support the view that osteoarthritis in the human hip is often due to ischaemia of the femoral head. Against this, Trueta and Trias found in the rabbit that after about 14 days of severe continuous pressure on the stifle joint there was irreversible interference with growth of the epiphysial cartilage due to compression damage and interruption of the blood supply. Hall showed in similar experiments in the young rat that articular surfaces of young animals were able to stand considerable compression without becoming necrotic and that this ability was retained even in maturity. Thus the evidence suggests that interference with the vascular epiphyseal cartilage is easier to achieve than interference with the relatively non-vascular articular cartilage. In this respect the intermittent high pressure on the main limb joints of the Antarctic husky could lead to changes in the epiphyseal cartilage, particularly in the growing animal. It is therefore most important that the musculo-skeletal system of the Antarctic dogs should be allowed to mature before they are expected to haul heavy loads.

Nutrition In short, it would appear that the diet of these dogs is not implicated in the occurrence of osteoarthritis.

Environment Extreme conditions must have a detrimental effect on the physiology of the Antarctic sledge dog, but it has not been possible to coordinate this with osteoarthritis.

CONCLUSION

In the British Antarctic Survey sledge dog, the stress and strains involved in pulling a loaded sledge in an adverse environment are the main factors causing exaggeration of degenerative changes in the hips and shoulders, here called osteoarthritis. It is suggested that the abnormal posture of the dogs while pulling causes incorrect distribution of great pressures on the joints, producing incorrect joint function. It is not known whether similar work-induced changes occur in other draught animals. It therefore appears that this condition could only be noticeably alleviated by changing the way of life of the dogs and thereby eliminating their usefulness.