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THORACO-LUMBAR DISK PROTRUSION WITH SEVERE CORD COMPRESSION IN THE DOG

II. CLINICAL OBSERVATIONS WITH SPECIAL REFERENCE TO THE PROGNOSIS IN CONSERVATIVE TREATMENT

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The development of the symptoms of motor loss in thoraco-lumbar disk protrusions in dogs has been discussed in Part I of this paper. The results obtained therein suggest that the time of the development of spinal cord compression is, in most cases, of such duration that there are good theoretical possibilities for decompressive surgical treatment before the damage to the spinal cord becomes irreversible. The present study, dealing with the prognosis in the conservative treatment of thoracic and lumbar intervertebral disk protrusions with severe compression of the spinal cord, was undertaken as a basis for the work dealing with the effect of surgical decompression (Part III).

MATERIAL AND METHODS

The material consists of 271 animals with a clinical diagnosis of thoracic or lumbar intervertebral disk protrusion. According to the records of the clinic the loss of voluntary movements during some part of the course of the disease was, in these cases, so severe that the animal was unable to walk on its hind legs. Of the material, 94 animals were treated at the Animal Hospital in Hälsingborg ("Djursjukhuset") between 1/1 1958 and 31/12 1961, 36 animals at the Animal Hospital in Skara ("Veterinärinrättningen") between 1/1 1958 and 31/12 1961, and 141 animals at the Department of Surgery, Royal Veterinary College,

In the Hälsingborg and Skara material the data concerning

Stockholm, between 1/1 1959 and 31/12 1961. In these animals, the age distribution for both the sexes did not diverge to any great extent from that of the total material recorded in Fig. 1, Part I. The medical treatment of the animals in Hälsingborg and Skara consisted of daily subcutaneous injections of vitamins of the B-complex at various dose rates, or peroral or subcutaneous administration of Butazolidine® (Geigy, Suisse) or Irgapyrine® (Geigy, Suisse). The drugs mentioned above were not, as a rule, used in the animals treated in Stockholm. Treatment common to all the three clinics was daily emptying of the urinary bladder by manual compression when necessary. In the animals where hemorrhagic cystitis was observed, additional treatment with antibiotics or chemotherapeutic agents was given.

In the Hälsingborg and Skara material the informations only dealt with the inability of the animals to walk with their hind legs at the time when symptoms of motor loss were maximal. The animals treated at the Veterinary College in Stockholm were subjected, in addition, to a simple neurological study involving assessment of the presence of voluntary movements, muscular tonus, and sensitivity to painful stimuli of the hind legs. Furthermore, the spinal reflexes (flexor reflex and extensor thrust reflex) were tested according to *Mc Grath* (1956). In subtotal paralysis, the remaining voluntary movements, irrespective of whether the symptoms of motor loss were stationary, progressing, or abating, were in the nature of small rhythmical, active movements of the hind legs synchronous with the movements of the forelegs. The presence of such movements was studied when the animal tried to walk to its handler or towards its cage. This test was performed both *without support*, with the animal dragging its hind legs on the ground, and *with support* by the tail so that the hind pads barely touched the ground. The first signs of returning voluntary movements were frequently observed in these tests, just when the dogs tried to crawl to their beds. Tonus of the muscles of the hind legs was judged to be present if there was resistance to passive movements. The sensitivity to painful stimuli was tested by pinching the interdigital skin folds or the pads of the hind legs with a towel clamp. The test was judged positive if the animal reacted by crying or by turning its head towards the clamp by pinching one or both of the hind legs. The control of the neurological status of the animals was made daily, if possible, during their stay in the clinic (1—3 weeks as a rule).

Table 1. Results of conservative treatment set out in relation to the maximal degree of motor loss observed and to the time of development of these symptoms. The table comprises the whole Stockholm-material.

Maximal degree of motor loss observed (for definition see text page 320)	Time of development of symptoms of motor loss (until inability to walk)	Total number of animals	Final outcome of the current attack				Miscellaneous symptoms			Re-currence
			Normal movements	Ability to walk but remaining disturbance of movements	No improvement; alive	Dead as a result of the cord injury or killed because of impairment of motor function or absence of improvement	Occurrence of signs of ascending paralysis in the animals recorded in the previous column	Remaining symptoms from urinary organs (incontinence or frequent micturition)	Remaining kyphosis	
Group I	Unknown but < 12 hours	8	2	4	1	1		2		3
	Instantaneous or < 15 min.	6	2	3	1				1	
	90 min. — 12 hours	6	2	3		1				
	12—24 hours	6	3	3						
	2—5 days	6	2	3		1			1	2
	> 7 days	1				1				
Total		33	11	16	2	4		2	2	5
Group II	Unknown but < 12 hours	22	4	3		15	1	1	1	3
	Instantaneous or < 15 min.	11	1	6		4			2	4
	90 min. — 12 hours	9	1	4		4		1		1
	12—24 hours	7		2		5				
	2—5 days	9	2	1		6				2
	> 7 days	6	1			5				
Total		64	9	16		39	1	4	3	10
Group III	Unknown but < 12 hours	18				18		13		
	Instantaneous or < 15 min.	6				6		5		
	90 min. — 12 hours	11				11		6		
	12—24 hours	5				5		2		
	2—5 days	3				3				
	> 7 days	1				1				
Total		44				44		26		

For tabular presentation, the material has been divided into the following groups based on the maximal degree of motor loss observed.

- Group I.* The animals were incapable of walking with their hind legs; some voluntary movements were observed in one or both of the hind legs.
- Group II.* The animals had completely lost the ability of voluntarily moving the hind legs, but some tonus of the muscles was present.
- Group III.* The animals completely lacked the ability of voluntarily moving the hind legs; the muscles were without tonus.

Details about the frequency and distribution of various symptoms in the material are given under the heading of "Results" in connection with the account of the results of treatment in animals showing the particular symptoms.

In the material from the Veterinary College in Stockholm, thoraco-lumbar myelography with Kontrast U (*Funkquist* 1962) was carried out in 74 animals. The myelography was done within 3 days after the onset of paralysis in 19 cases, after 4—7 days in 22 cases, after 8—14 days in 19 cases, after 15—31 days in 6 cases, and after more than a month in 8 cases. In 65 of the cases, enough contrast medium was deposited in the subarachnoid space to visualize the cranial as well as the caudal limits of the myelographic changes. The extent of the myelographic changes and their relationship to the degree of motor loss at the culmination of the attack and to the prognosis are presented in Table 7. The extent of the myelographic changes was ≤ 2 vertebrae in 40 animals and > 2 vertebrae in 25 animals. The various types of changes encountered in the material were described in a previous paper (*Funkquist* 1962). In 7 cases the myelograms showed a typical picture of myelomalacia.

In 116 of the cases in Stockholm the interval between the time the animal lost its ability to walk with the hind legs and the first clinical investigation varied between 3 hours and 7 days. In the remaining 25 cases the interval was more than 7 days. The first investigation was made within 3 days in 82 cases and within 12 hours in 24 of these 82 cases.

The time of observation of the treated animals which died or

Table 2. Results of conservative treatment in relation to the maximal degree of motor loss observed and to the time of development of these symptoms. The table comprises those animals which were examined within three days after onset of paralysis (loss of ability to walk).

Maximal degree of motor loss observed (for definition see text page 320)	Time of development of symptoms of motor loss (until inability to walk)	Total number of animals	Final outcome of the current attack				Miscellaneous symptoms
			Normal movements	Ability to walk but remaining disturbance of movements	No improvement; alive	Dead as a result of the cord injury or killed because of impairment of motor function or absence of improvement	
Group I	Unknown but < 12 hours	3	1	2			
	Instantaneous or < 15 min.	3	1	2			
	90 min. — 12 hours	5	2	3			
	12—24 hours	5	3	2			
	2—5 days	2	1	1			
> 7 days	1				1		
Total		19	8	10		1	
Group II	Unknown but < 12 hours	14	4	3		7	1
	Instantaneous or < 15 min.	6	2	1		3	
	90 min. — 12 hours	4		3		1	
	12—24 hours	2				2	
	2—5 days	4	2	1		1	
> 7 days	3	1			2		
Total		33	9	8		16	1
Group III	Unknown but < 12 hours	13				13	11
	Instantaneous or < 15 min.	6				6	5
	90 min. — 12 hours	6				6	4
	12—24 hours	3				3	1
	2—5 days	1				1	
> 7 days	1				1		
Total		30				30	21

were destroyed without having shown sign of improvement is presented in Table 6. The time of observation for those animals in the Stockholm material that regained their ability to walk is presented in Diagram b. In addition, the Stockholm material includes 2 dogs which were observed for 6 months and 3 years respectively without any obvious signs of improvement in the movements of the hind legs. The follow-up of the Hälsingborg and Skara material was only intended to reveal whether or not the animals were able to walk with the hind legs. For the Stockholm material investigations were made to ascertain the status of the animals in more detail (presence of unsteadiness or abnormal posture among those animals which regained their ability to walk). In general, the follow-up was made by telephone and was based upon the opinion of the owner concerning the condition of the dog. In 12 questionable cases belonging to the Stockholm material the dogs were brought to the clinic for the follow-up.

Patho-anatomic studies of the epidural space and the spinal cord and its meninges were made in 78 of the 87 animals in the Stockholm material that died or were destroyed. These studies were carried out as described in a previous paper (*Funkquist* 1962). In all the cases examined, the diagnosis of disk protrusion was verified. The types of disk protrusion observed at the investigation have been presented — for the majority of the cases — in Part I.

RESULTS

Of the animals treated at the clinic in Hälsingborg, 45.7 per cent (43 of 94 dogs) improved within the given time of observation, so that they were able to walk with their hind legs. The corresponding figures for the clinics in Skara and in Stockholm were 47.2 per cent (17 of 36) and 36.9 per cent (52 of 141) respectively.

In the following, only the results concerning the Stockholm material are dealt with.

Five animals died during the stay at the clinic, 3 during the first week and 2 during the second week after the onset of paralysis. None of these 5 animals showed signs of voluntary motor function or pain sensitivity of the hind legs. Autopsy was performed in 4 of the animals. In all 4 cases, extended myelomalacia in the thoracic and lumbar region could be demonstrated. Eighty-

Table 3. Results of conservative treatment in relation to the maximal degree of motor loss observed and to the time of development of these symptoms. The table comprises those animals which were examined on the day of onset of paralysis (loss of ability to walk).

Maximal degree of motor loss observed (for definition see text page 320)	Time of development of symptoms of motor loss (until inability to walk)	Total number of animals	Final outcome of the current attack				Miscellaneous symptoms	
			Normal movements	Ability to walk but remaining disturbance of movements	No improvement; alive	Dead as a result of the cord injury or killed because of impairment of motor function or absence of improvement		
Group I	Unknown but < 12 hours	1		1			Occurrence of signs of ascending paralysis in the animals recorded in the previous column	
	Instantaneous or < 15 min.							
	90 min.—12 hours	1		1				
	12—24 hours	3	2	1				
	2—5 days							
> 7 days								
Total		5	2	3				
Group II	Unknown but < 12 hours	5	3	1		1		
	Instantaneous or < 15 min.							
	90 min.—12 hours	4	1	2		1		
	12—24 hours	3	1	1		1		
	2—5 days							
> 7 days								
Total		12	5	4	3	1		
Group III	Unknown but < 12 hours	5			5	5		
	Instantaneous or < 15 min.							
	90 min.—12 hours	1				1		
	12—24 hours							
	2—5 days	1				1		
> 7 days								
Total		7		7	7	6		

two animals were destroyed after varying times of observation (Table 6). Seventy-eight of these animals showed complete sensory¹⁾ and motor paralysis at the time of sacrificing. In 4 cases there were weak voluntary movements (but no pain sensitivity) during the whole time of observation (Table 6).

Of the 52 animals in the Stockholm material that regained their ability to walk with the hind legs, 20 (14.2 per cent of the whole Stockholm material) showed normal movements, while 32 (22.7 per cent of the whole Stockholm material) although they regained the ability to walk showed a residual unsteadiness of varying degree.

A more detailed analysis of the whole Stockholm material is given in Table 1, where the results of the treatment are shown in relation to the following factors: 1. the maximal degree of motor loss (Groups I, II and III according to the definition on page 4) during the time of observation at the clinic, and 2. the time of development of the symptoms of motor loss (to the state "inability to walk"). As a great number of these animals arrived at the clinic so late that they may have been recovering from a previous total paralysis, Table I has been supplemented with Tables 2 and 3, where the results of the treatment have been related in a corresponding way to the maximal degree of motor loss observed in the animals admitted within the first 3 days (Table 2), and within 12 hours (Table 3), after the onset of paralysis. To obtain material suitable for a direct comparison with the operated cases, the animals included in Table 3 (examined on the day of onset of paralysis) have been arranged according to their status at the first examination (Table 4). As a comparison of the results of conservative and surgical treatment will be made in Part III, it should be noted, that the animals in Table 4 during the first 12 hours of their stay at the clinic did not show any development of the symptoms of motor loss.

Sensitivity to painful stimuli of the hind legs existed during the whole time of observation in 20 of the 33 cases within the group where some voluntary movements of the hind legs were present (Group I in Table 1). In the group where the animals were completely without voluntary movements but had muscular tonus (Group II), pain sensitivity could be demonstrated only in 6 of the 58 cases in which this type of study could be per-

¹⁾ Certainly assessable in 72 cases.

Table 4. Results of conservative treatment in animals admitted on the day of onset of paralysis (loss of ability to walk). The grouping is performed according to the status on the day of admission; otherwise it corresponds to the definitions given in text, page 320.

Degree of motor loss on the day of admission	Time of development of symptoms of motor loss (until inability to walk)	Total number of animals	Final outcome of the current attack			Occurrence of signs of ascending paralysis in the animals recorded in the previous column	Occurrence of impairment of motor function later than 12 hours after admission
			Normal movements	Ability to walk but remaining disturbance of movements	Dead as a result of the cord injury or killed because of impairment of motor function or absence of improvement		
Group I	Unknown but < 12 hours	2	1	1			1
	Instantaneous or < 15 min.						
	90 min. — 12 hours	4	1	2	1		3
	12—24 hours	3	2	1			
	2—5 days	1			1		1
> 7 days							
Total		10	4	4	2		5
Group II	Unknown but < 12 hours	5	2	1	2		2
	Instantaneous or < 15 min.						
	90 min. — 12 hours	1		1			
	12—24 hours	3	1	1	1		
	2—5 days						
> 7 days							
Total		9	3	3	3		2
Group III	Unknown but < 12 hours	4			4		4
	Instantaneous or < 15 min.						
	90 min. — 12 hours	1			1		1
	12—24 hours						
	2—5 days						
> 7 days							
Total		5			5		5

formed (the group included 64 cases in all). In the group without muscular tonus (Group III), pain sensitivity could not be demonstrated in any of the 44 cases in the group. In the animals where the pain sensitivity was completely lost, the absence of this function had as a rule already been demonstrated at the first investigation. However, in 6 animals, the pain sensitivity disappeared during the stay at the clinic. This happened 1—4 days after the onset of paralysis. In those animals in the Stockholm material that were destroyed, pain sensitivity was lacking in all the assessable cases. The relationship of the remaining pain sensitivity to the chances for the recovery of the animals that had completely lost their voluntary motor function but showed muscular tonus (Group II) is listed in Table 5.

Table 5. Relation between the presence of pain sensitivity of the hind paws and the results of conservative treatment in animals belonging to group II (residual muscular tonus but absence of voluntary movements of the hind legs).

Maximal degree of sensory loss during the time of observation	Total number of animals	Final outcome of the current attack		
		Normal movements	Ability to walk but remaining disturbance of movements	Dead or killed because of impairment or absence of improvement
Pain sensitivity	6	5	1	
Lack of pain sensitivity	52	4	15	33

It was possible to demonstrate flexor reflexes — even at the maximal degree of motor loss observed — in all animals with muscular tonus (Groups I and II in Table 1). In 33 of the 44 animals in Group III (no muscular tonus) the flexor reflexes were either absent at admission or disappeared or they became very weak during the course of the disease. In only 11 animals, strong flexor reflexes remained during the whole time of observation (6—24 days in 8 cases and 5—8 weeks in 3 cases). The changes in the state of the flexor reflexes in ascending paralysis are described below.

A weakened extensor thrust reflex was often present at the first examination of those animals in Group I (signs of voluntary movements), which came for examination in the first few days after they lost the ability to walk. In the other animals in Group I

and in the animals in Group II, the extensor thrust reflex as such, was missing. In these animals however, a testing of this reflex frequently elicited a tonic contraction of the stretching muscles of the examined leg. In Group III the corresponding examination elicited no reaction.

Hyperreflexia in the hind quarters, either in form of a strong crossed extensor reflex (*Mc Grath* 1956) or other atypical reflexes, such as rapid movements of tail and hind legs at a slight touching of the skin of the hind quarters, was observed in 22 cases. These signs of hyperreflexia appeared in 2 cases about 1 week after the onset of paralysis, in 8 cases after 10 days, and in 9 cases after more than 2 weeks. Of the 22 animals discussed, 17 were destroyed 1—8 weeks after the onset of paralysis because the prognosis was judged hopeless. Two of the remaining 5 animals, during the time of observation of 6 months and 3 years respectively, did not show any signs of voluntary movements, while 3 animals regained the ability to walk after 3, 4, and 6 months respectively. At the end of the observation time, 7—10 months after the onset of paralysis, these animals were still markedly unsteady.

Of the more unusual symptoms observed at the examinations, the following seem to be of some interest:

Obvious atrophy of the muscles of the hind quarters was observed in 13 animals. In 3 animals, this symptom was observed about 1 week after the onset of paralysis and in the rest of the animals after 2—4 weeks. Three of the animals recovered completely, while the other ten were destroyed 1—8 weeks after the onset of paralysis as there were no signs of improvement.

Kyphosis of a more transient sort was observed in many cases in the acute stage of the attack. In 5 dogs that regained their ability to walk, a slight kyphosis remained during the whole course of the observation time (varying between 6 weeks and 31 months).

Symptoms from the urinary organs in the form of frequent micturitions, a slight incontinence or hematuria persisted in 6 dogs (after regaining the ability to walk) during the whole time of observation, varying between 3 and 23 months.

Concerning the relationship between the myelographic changes on one hand and the clinical picture and the results of the treatment respectively on the other, the following should be mentioned. If the animals investigated by myelography are divided

according to the extent of the myelographic changes (< 2 vertebrae and > 2 vertebrae respectively) and if these groups are subdivided into Groups I—III according to the clinical symptoms (definition on page 320), it becomes obvious (Table 7), that in the group with extensive myelographic changes, there are relatively more animals (14/25) belonging to Group III (characterized, *inter alia*, by a bad prognosis) than in the group with limited myelographic changes (9/40). *Within* a group of animals with the same degree of motor loss however (I, II or III), there does not seem to be any obvious relation between the extent of the myelographic changes and the prognosis.

The return of voluntary motor activity was characterized in its first phase by small rhythmical movements of the hind legs (synchronous with the movements of the forelegs); this has already been described in the description of the technique for examination. In the next phase, the animals made strong crawling movements and attempted to rise. After the animals regained the ability to walk, they moved unsteadily at first when trotting and frequently preferred galloping to trotting. In the animals that gradually regained normal movements, the last remaining sign of disturbance in the movements has frequently been a difficulty in keeping the balance of the body in sharp turns, when running at a high speed. In 23 of the animals that had complete motor paralysis, it was possible to follow in detail the motor functions during recovery. The result of this study is given in Diagram a, where the animals were placed according to the time of the first sign of voluntary movements. The course of recovery for all 52 animals which regained their ability to walk is given in Diagram b, where the animals were placed according to the time (counted from the onset of paralysis) at which they regained their ability to walk on the hind legs.

Symptoms of recurrence were observed in 15 cases in all (28.8 per cent of the animals that regained their ability to walk). The distribution of the recurrences in the material is given in Table 1. In about 50 per cent of these cases, the recurrence appeared within 14 weeks. In 6 cases the symptoms were in the nature of transient attacks of pain. In 5 animals the recurrence took the form of a transient paralysis of the hind quarters. In 2 animals there were repeated attacks of severe compression of the spinal cord, which caused the destruction of the animals after 1 and 1½ years respectively. Finally, 2 animals were de-

stroyed as the result of an acute paralysis which appeared 10 and 14 weeks respectively after the first attack.

From the total material one can distinguish two groups which in the course of the disease have diverged considerably from the average. These are on one hand, the animals whose symptoms of motor loss developed particularly slowly and on the other hand, the animals in which ascending paralysis developed.

An exceptionally slow development of the symptoms of motor loss was observed in 8 animals altogether (time for development 1—2 weeks in 5 cases, 3—4 weeks in 2 cases, and 8 weeks in 1 case). In 1 of these animals, some voluntary motor activity remained during the whole course of the disease. This dog was destroyed about 2 months after the onset of the symptoms of motor loss without having shown any signs of recovery. In the remaining 7 animals, a complete paralysis of the voluntary motor functions developed. Six of these 7 animals were destroyed 7—17 days after the onset of paralysis. At the time of destruction 1 of the animals showed a flaccid paralysis without spinal reflexes and without pain sensitivity in the hind legs, while the remaining 5 showed paralysis with remaining tonus in the muscles of the hind legs (in 4 of these 5 cases there was no pain sensitivity). The seventh animal, after about 1 month's paralysis (with remaining muscle tonus and remaining but weakened pain sensitivity) showed signs of returning voluntary motor activity. The animal regained its ability to walk about 10 weeks after the onset of paralysis and the movements were normal after a further 4 weeks. Patho-anatomic investigation was performed in 6 of the animals that were destroyed. In all these 6 animals, it was demonstrated that the morphological basis for the symptoms of cord compression was a "buttonlike" disk protrusion, which had caused a sharply delimited impression in the spinal cord (disk protrusion of type 1 according to the definition given in Part I).

The second of the two groups with a divergent course of the disease, consisted of those animals which showed symptoms of ascending paralysis. Progressive ascending paralysis (*Mc Grath* 1951 and 1956, *Olsson* 1951 and 1960, *Hoerlein* 1953, *Smith and King* 1954, *Vaughan* 1958) was observed in 27 dogs in the Stockholm material (19.1 per cent of the material). In the 26 animals about whom it was possible to get information concerning the time of development of the symptoms of motor loss (to the state "inability to walk") the time of development in all 26 cases was

less than 24 hours. At the first examination after admission, 4 hours—5 days after the onset of paralysis, signs of voluntary movements of the hind legs remained in 1 case. Remaining muscular tonus was present in 2 animals in spite of the total paralysis of voluntary motor activity. The remaining 24 animals had flaccid paralysis, 12 of them however, showing flexor reflexes and 1 animal pain sensitivity in addition.

The interval between the time when the animal lost its ability to walk and the first signs of progressive ascending paralysis varied between 1 and 10 days. In the majority of the cases the interval was 1—3 days. At an early stage, the animals were in the habit of sitting with stiff forelegs and the head directed stiffly upwards. At the examination the dogs showed signs of intense pain. The general condition gradually became strongly affected and the animals frequently looked dazed. In 26 animals, flaccid paralysis with hypo- or areflexia in the hind quarters was present at the admission (*cf.* above) or developed during the stay at the clinic. In the remaining animal, destroyed in the initial stage, a certain degree of tonus in the muscles and strong flexor reflexes were still present at the time of destruction. In 13 animals, the symptoms of motor loss progressed to quadriplegia, generally accompanied by a subnormal rectal temperature. This state was reached at varying times (3—7 days) after the onset of paralysis. Twenty-six of the animals have either died (3) or been destroyed (23) within one week of the animals' losing their ability to walk on the hind legs. The remaining animal died after 13 days. Patho-anatomic examination was performed in 25 cases. In 24 of these cases, the disk protrusion proved to be of type 3 and in 1 case of type 2 (according to the nomenclature given in Part I). This means that in all cases, some (type 2) or all (type 3) of the protruded disk masses, were spread out diffusely in the epidural space. The disk substance extended over 1—11 vertebrae; the amount of substance, as a rule, being greatest at the 1—3 vertebrae situated nearest to the ruptured disk. In 19 cases, the extent of the disk substance was longer than 2 vertebrae. The patho-anatomic changes in the spinal cord in 2 animals (destroyed 1 and 3 days respectively after the onset of paralysis with one as mentioned above still showing flexor reflexes and muscular tonus of the hind legs), were restricted to extensive oedema. In these cases there was a subarachnoid bleeding as well. In the remaining 23 animals (which died or were destroyed 1—13 days after the

onset of paralysis), there was an extensive, macroscopically visible myelomalacia (described by *Mc Grath* 1951 and 1956, *Hansen* 1952, *Olsson* 1960). In most cases (18/23) myelomalacia extended far beyond the region of the protruded disk substance, particularly in the cranial direction. The greatest extension of the changes in the cross-section of the spinal cord was, as a rule, *within* the region of the protrusion. In most cases the softening of the spinal cord in *some* area included the whole cross-section of the cord.

DISCUSSION

a) The material

There is reason to suppose that the material from the Stockholm clinic may form a selection of particularly severe cases. This is because a certain number of disk protrusions with transient paralysis may have occurred and been treated by practising veterinarians. Further, on selecting cases for surgical treatment (the results will be described in Part III) animals were chosen which, at the time of examination, had signs of remaining voluntary motor functions. The good agreement — on the whole — between the results from the material of the Stockholm clinic and the clinics in Hälsingborg and Skara (where the former reason for selection ought to be insignificant because of the organization of the animal care, and where no surgical treatment was performed) suggests that the supposed selection has not played any predominant rôle in the results of the treatment.

Furthermore it should be mentioned, that the results of treatment from the three clinics above do not diverge appreciably from the results ("excellent" in 9 of 18 animals) of corresponding conservative treatment reported by *Jadason* (1961) (provided that the "excellent" group of this author includes all the animals which regained their ability to walk). The results also agree satisfactorily with *Hoerlein's* report (1956) of 32 "good" or "fair" results in 62 animals treated conservatively. This is especially true if the fact that Hoerlein excluded a number of animals, judged hopeless from the beginning, is taken into consideration. The number is not stated exactly but was obviously less than 12.

b) Time of observation

As there were no signs of improvement, 56 of the animals in the Stockholm material were sacrificed within 2 weeks after the

Table 6. Time of observation for animals which died as a result of the cord injury or were killed because of impairment of motor function or absence of improvement. In the Stockholm material there was complete sensory and motor paralysis in all cases except in 4 cases (marked with ¹⁾ and ²⁾) which showed slight signs of voluntary movements; particulars for the animals in Hälsingborg and Skara are not available.

Animal Hospital	Total number of animals	Time of observation from onset of paralysis (loss of ability to walk)						
		≤ 1 week	1-2 weeks	2-3 weeks	3-4 weeks	4-6 weeks	6-8 weeks	> 2 months
Hälsingborg	51	24	4	6	3	10		4
Skara	19	10	5	1		1		2
Stockholm	87	35 ¹⁾	21	12	9 ²⁾	7 ²⁾	3	

¹⁾ slight signs of voluntary movements in 2 cases.

²⁾ slight signs of voluntary movements in 1 case.

onset of the paralysis. Of these animals 35 were sacrificed during the first week. According to *Tarlov* and co-workers (1954) whose results were discussed in Part I of this paper, the first signs of returning voluntary movements after an experimental compression of the spinal cord with complete paralysis, occurred within 2 weeks in most of the animals that regained normal ability to move. Complete restitution (after a maximum of 180 days) occurred, however, even when the paralysis lasted up to 32 days before the first signs of recovery were observed. The application of *Tarlov's* results to the present material would mean that a considerable number of the cases could not be used for this study because the time of observation is too short (Table 6). It should be pointed out however, that the compression of the spinal cord in disk protrusion is caused by disk masses which, in so far as configuration, extent and location in the epidural space are concerned, are considerably different from the compressing rubber balloons in the experimental dogs; furthermore, the balloons in the experimental animals were emptied completely at a relatively early stage, while in conservatively treated disk protrusion even under the best conditions the reduction of the volume of the compressing structures in the epidural space can be expected to begin late and progress slowly. Thus, it is not justifiable to take for granted that there should be the same chances of recovery in a case of disk protrusion as in an animal subjected to experimental compression of the spinal cord, even if the animals show a corresponding course of the initial recovery. Therefore,

in this study, an attempt has been made to use the course of the recovery in the animals with a *long* time of observation, to form a general idea about the prognosis for those animals whose time of observation was relatively short. The following facts were considered:

I. *The establishment of the latest time at which complete recovery can still be expected*

The time at which complete restitution of motor function was attained in the animals observed is recorded in Diagram b. To make the results more easily surveyed with regard to the current question they have also been presented in Table 8. As is evident from the diagram and table, transition from the state "ability to walk but with remaining disturbance of movements" to the state "completely normal movements" did not occur later than 9 months after the onset of paralysis, although a considerable number of animals exceeded this length of observation time still showing residual disturbance of movements. This fact seems to justify the suggestion that the animals which have passed the 9-month-limit and still have disturbances of the movements would have small chances of complete recovery.

II. *The relationship between the course of the first phase of recovery and the prospects of complete restitution*

Tarlov's results suggest that after experimental compression of the spinal cord with complete paralysis, there is as a rule, a tendency for a positive correlation between the time which elapses before the animal shows the first signs of returning voluntary motor activity and the time needed for complete restitution. For this reason it seems logical to assume that, when studying a series of animals arranged according to the speed of improvement during the first phase of recovery, one will find a lower limit for the speed of improvement compatible with *complete* restitution in the subsequent course of the disease — *i. e.*, animals which improve during the first phase of recovery at a speed below that limit will show *permanent* disturbance of movements. In analysing the material of the present study from this point of view, the speed of recovery was estimated in the following way. For one group of animals, about whom detailed information was available, the speed of improvement was judged by the time, at which the first signs of voluntary motor activity were observed

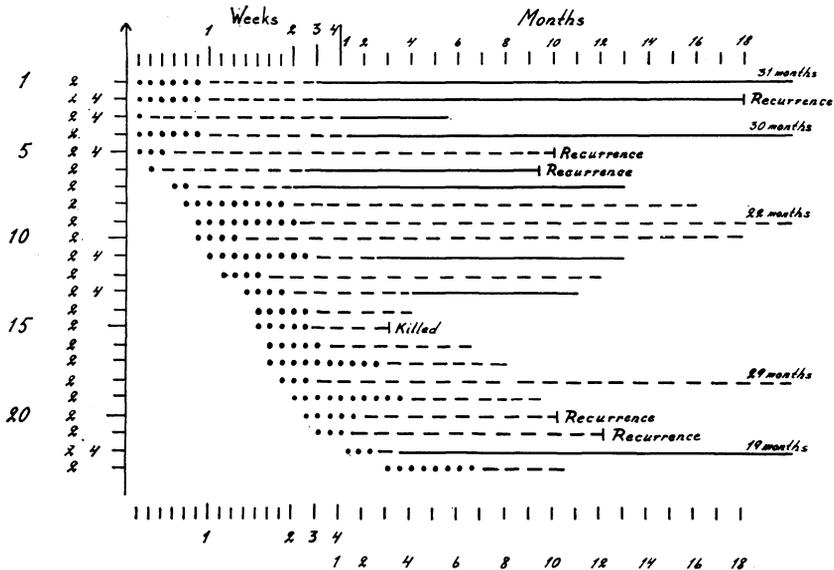


Diagram a. Course of recovery after complete motor paralysis caused by thoracolumbar intervertebral disk protrusion. The diagram includes only those animals of the Stockholm material, for which exact information was available concerning the time of the first signs of returning voluntary motor activity of the hind legs. The dogs are arranged according to this time. The numbers in sequence are given in the margin to the left. Zero line indicates day of onset of paralysis (loss of ability to walk). See Table of signs, page 335.

(Diagram a). For a larger group of animals (including the animals in Diagram a) the speed of improvement was judged by the time at which the animals had just regained the ability to walk (Diagram b).

It soon became evident that an obvious relationship between the speed of the initial improvement and the prospects of complete restitution does not exist when only the speed of motor recovery is considered. If however, both the speed of motor improvement and the presence of pain sensibility are taken into consideration, the following are found:

1. (According to Diagram a). None of the 13 completely paralysed animals, which at the climax of the attack lacked pain sensitivity and showed the first signs of returning voluntary movements 5 days or more after the onset of the paralysis (nos. 8, 9, 10, 12, 14, 15, 16, 17, 18, 19, 20, 21 and 23 in Diagram a),

regained their ability to walk normally. It should be considered that 9 of the animals were observed for more than 9 months, and 4 animals for more than 12 months. In that group of animals, on the other hand, where during the whole course of the disease pain sensitivity remained, complete restitution was observed (nos. 11, 13 and 22) even if it lasted 7—33 days before the first signs of voluntary motor activity appeared.

2. (According to Diagram b). Of the 15 animals (nos. 21, 29, 30, 32, 35, 36, 37, 38, 41, 43, 45, 47, 50, 51 and 52) which at the height of the attack showed signs of complete sensory and motor paralysis and which regained their ability to walk after 10 days or

Diagram b. Course of recovery for those dogs of the Stockholm material which regained the ability to walk after total or subtotal paralysis, caused by thoracolumbar intervertebral disk protrusion. The animals are arranged according to the time at which they regained the ability to walk. The numbers in sequence are given in the margin to the left. Zero line indicates time of onset of paralysis. For meaning of signs see Table of signs (voluntary movements without ability to walk (. . .)) are not shown in Diagram b).

x = Destroyed because of intercurrent disease

† = Dead from intercurrent disease

Thirty-five animals admitted within 3 days after the onset of paralysis. Twenty-six of these 35 animals admitted within 24 hours. (Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 16, 17, 21, 23, 24, 25, 29, 30, 31, 37, 38, 40, 45, 48)

Table of signs (common to Diagram a and b).

Functional state of spinal cord during the attack.

1—2. Maximal degree of motor loss observed.

1. Dog unable to walk; some voluntary motor activity.
2. Total paralysis of voluntary motor activity of the hind legs. Muscular tone of varying strength is present.

4. Presence of pain sensitivity during the observation time.

Course of recovery.

. the dog is unable to walk but shows some voluntary motor activity of the hind legs.

----- the dog can walk but it shows disturbance of movements (unsteadiness) of varying degree.

———— the dog walks normally.

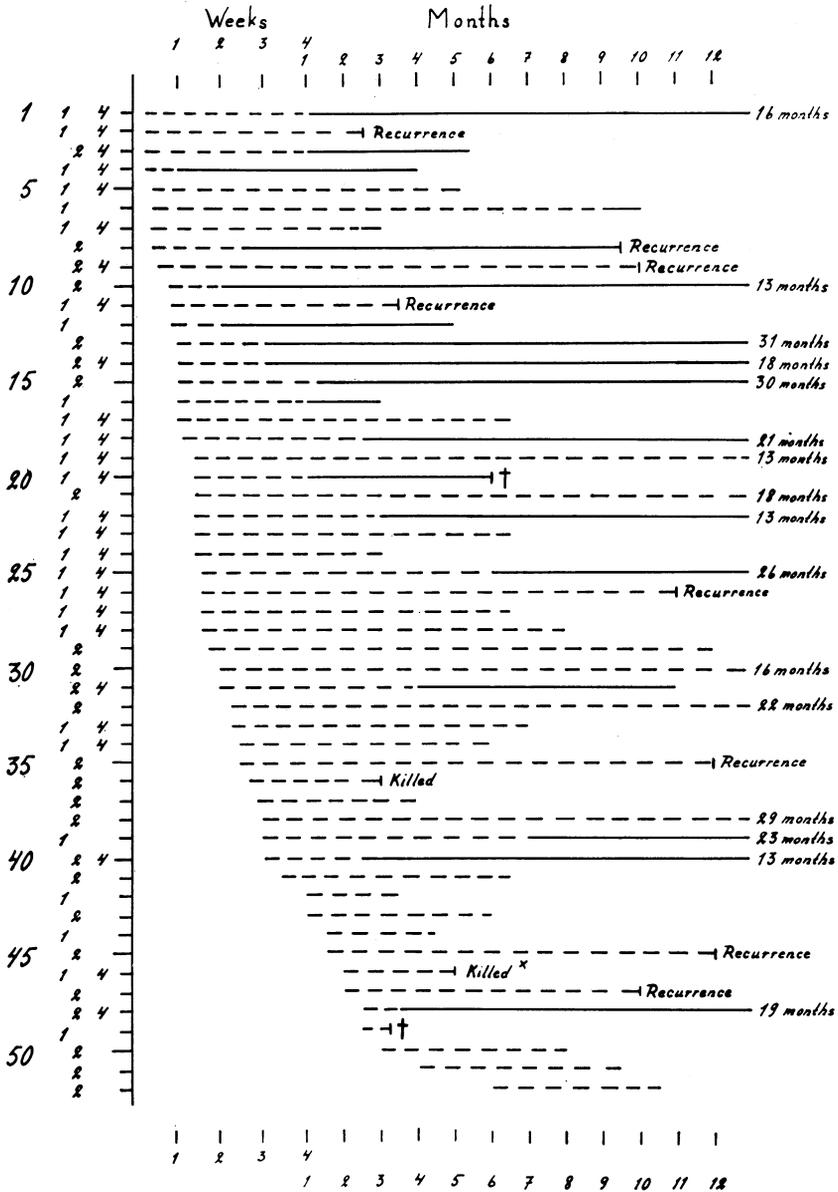


Diagram b (see text pag. 335).

Table 7. Extent of myelographic changes compared with the degree of motor loss at the maximum of the attack and with the results of conservative treatment.

Extent of myelographic changes	Degree of motor loss (for definition see text page 320)	Total number of animals	Final outcome of the current attack			Occurrence of extensive myelomalacia in the animals recorded in the previous column
			Normal movements	Ability to walk but remaining disturbance of movements	Dead as a result of the cord injury or killed because of impairment of motor function or absence of improvement	
≤ 2 vertebrae	Group I	6	1	5		
	„ II	25	3	8	14	
	„ III	9			9	2
	Total	40	4	13	23	2
> 2 vertebrae	Group I	2	2			
	„ II	9	1	3	5	
	„ III	14 ¹⁾			14	10
	Total	25	3	3	19	10

1) including 7 animals with myelographic findings indicating myelomalacia.

more, none regained normal movements. The time of observation in these cases was more than 9 months for 10 animals, more than 12 months for 4 animals, and more than 24 months for 1 animal. The animals with remaining pain sensitivity (3 animals, nos. 31, 40, 48) or remaining voluntary motor activity (1 animal, no. 25) during the whole course of the disease, on the other hand, recovered completely, although the ability to walk was regained more than 10 days after the onset of the attack.¹⁾

To sum up, it seems justified to suggest the following in view of the above discussion:

Firstly, the animals which still showed disturbances in the movements 9 months after paraplegia caused by disk protrusion, seem to have small chances of regaining normal movements of the hind legs.

1) The 4 last-mentioned animals were admitted on the day of the onset of paralysis. The other 4 animals in Diagram b (nos. 20, 22 and 39) with corresponding status and course of recovery have not been discussed while they had not been under control from the first day of paralysis.

Table 8. Time for complete recovery (normal movements) for 20 animals of the 52 animals which regained their ability to walk with the hind legs.

	Time in months after onset of paralysis								
	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27
Number of animals recovered	15/51	3/27	2/15	0/8	0/4	0/3	0/2	0/1	0/1
Number of animals observed									

Nominator: Number of animals completely recovered during the current period.

Denominator: Sum of nominator and number of animals with remaining disturbance of movements observed during the whole *current* period. The table is an extract of Diagram b (page 336).

Secondly, those animals which, after complete *motor* and *sensory* paralysis show the first signs of returning voluntary movements 5 days or more after the onset of paralysis or regain their ability to walk on the hind legs 10 days or more after the onset of paralysis also have rather small chances of regaining normal movements.

In considering the above discussion for the obtaining of information about the influence of a prolonged time of observation on the results of the treatment of this disk protrusion material, the following will be found:

1. *The animals sacrificed at a relatively early stage without having shown any signs of improvement*

Of the 35 animals which were sacrificed during the first 7 days, 26 animals showed signs of ascending paralysis. Since restitution in these cases is improbable they are not discussed. (Myelomalacia was demonstrated in 22 of the 24 animals in the group subjected to patho-anatomic examination). Two of the remaining 9 animals (without signs of ascending paralysis) were sacrificed after 2 and 4 days respectively (one showing signs of voluntary motor activity at the time of sacrificing). For the rest of the group (7 animals) the observation time was 5 days or more. One of these 7 animals showed signs of voluntary motor activity at least as soon as the fourth day after onset of paralysis, while 6 animals showed complete motor and sensory paralysis at the time of sacrificing. The possibility of some of these 9 animals regaining the ability to walk if the time of observation had been prolonged cannot of course be excluded. Further, from

the facts given in the introduction of the discussion under point II, it is obvious that those 3 animals mentioned above, which were sacrificed at a rather early stage and/or showed signs of voluntary movements within 4 days after the onset of paralysis may have had a chance of *complete* recovery. For those 6 animals that were observed for 5 days or more, and did not show signs of voluntary movement, there seems to have been little chance of their regaining *normal* movements.

In the animals sacrificed later than 7 days after the onset of paralysis there were included 2 dogs, which showed slight voluntary movements from a time that could not be established with certainty. In these cases the possibility of *complete* recovery cannot be excluded.

2. *The animals which during the time of observation regained their ability to walk but still showed disturbances in the movements*

Of the 52 animals recorded in Diagram b, 27 animals were observed for more than 9 months. According to the discussion under I, a prolonged observation time may not increase to any great extent the number of animals within this group which completely recover. Of the remaining 25 animals (not observed for the full 9 months), 6 had recovered completely at the time of the follow-up examination. Of the remaining 19 animals, 5 had had complete motor and sensory paralysis and had in addition regained their ability to walk after more than 10 days (nos. 36, 37, 41, 43 and 50). Thus, these animals showed the full range of neurological symptoms which indicate slight chances for *complete* recovery. The remaining 14 animals (of the 19 animals) with residual disturbance of movements and an observation time of less than 9 months may have belonged — as regards the neurological symptoms¹⁾ and the primary course of recovery — to the category within which complete restitution was observed to a relatively great extent (voluntary movements and in most cases pain sensitivity; early recovery to the stage “ability to walk”).

If, on the basis of the above discussion, an attempt is made to evaluate the possible influence on the results of the treatment by, on one hand, a prolongation of the period of observation of

¹⁾ Only 5 dogs (nos. 2, 5, 17, 23, 24) observed from the first day of the paralysis.

the unrecovered dogs before they were sacrificed and, on the other, a prolongation of the time of observation for the improved — but not completely recovered — dogs, the following will be found: A prolongation of the former time factor could of course have produced an increased number of animals that regained their ability to walk. On the other hand, the number of *completely* recovered animals would be unlikely to increase by more than 5 at the best. As for the influence of the other time factor, a prolonged time of observation would at best increase the number of completely recovered animals by about 14. This means that a longer period of waiting before destruction of the unimproved animals and a prolonged observation time of the improved animals would, at best, have increased the number of *completely recovered* animals in the Stockholm material to 39 *i. e.* about 30 per cent (27.7 per cent = 39/141).

c) Facts of importance for the practical use of the results in judging the chances of recovery

In considering the relationship between the degree of the symptoms of functional disturbances and the chances of recovery, the following points should be stressed: Of the animals in which a certain voluntary motor activity was demonstrated during the attack, the majority regained their ability to walk (27/33 cases in Table 1, 18/19 cases in Table 2, and 5/5 cases in Table 3). A large percentage of these animals have, however, shown a long lasting and probably permanent disturbance in the movements. Of the animals that showed a complete loss of voluntary motor activity but remaining tonus in the hind leg muscles, considerably fewer regained their ability to walk (25/64 in Table 1, 17/33 in Table 2, and 9/12 in Table 3). Also in this group, the frequency of remaining disturbances of movements was high. Finally, of the 44 animals that showed paralysis without muscular tonus of the hind legs, no animal regained its ability to walk. In the practical application of these facts on clinical cases the possible influence of a prolonged observation time (see discussion, point b) should be taken into consideration.

In considering the relationship between the speed of development of the symptoms of motor loss and the final outcome, it should be pointed out that in the group where the symptoms developed rapidly — within 12 hours — the frequency of ascending paralysis was 25/97 while the frequency among animals with a

longer time of development was only 2/44 (Table 1). Apart from the danger of myelomalacia, rapid development of the symptoms of motor loss does not seem to have any obvious importance for the prognosis.

In animals with complete motor paralysis, remaining pain sensitivity seems to be a positive sign for the prognosis (Table 5, Diagram a and b).

The chances of recovery regarded as a function of both the maximum degree of functional disturbances and the speed at which the motor functions return, were discussed above in connection with the influence of the length of the observation time on the results of conservative treatment. In summary, it should be pointed out that those animals, that during some phase of the disk-protrusion attack, showed *complete sensory and motor paralysis* and exhibited the first signs of returning voluntary movements 5 days or more after the onset of the paralysis or regained their ability to walk after 10 days or more, seem to have small chances of completely regaining their *normal* ability to walk.

The presence of hyperreflexia suggests severe damage of the spinal cord but does not completely exclude the possibility of the animal's recovering to such a degree that ability to walk on the hind legs is regained.

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SUMMARY

The author has studied the results of conservative treatment in dogs with symptoms of thoraco-lumbar disk protrusions of such severity that the animals were unable to walk on their hind legs. The material comprises 141 dogs treated at the surgical clinic, Royal Veterinary College ("Veterinärhögskolan"), Stockholm, 94 dogs treated at the Animal Hospital, ("Djursjukhuset"), Hälsingborg, and 36 dogs treated at the Animal Hospital, ("Veterinärinrättningen"), Skara. Of the animals treated, 36.9, 45.7 and 47.2 per cent respectively recovered to such a degree that they regained their ability to walk on the hind legs (with or without disturbance of movements). In the Stockholm material which was analysed in more details, 14.2 per cent regained normal movements within the time of observation. If the length of the observation time and the clinical course of the disease are taken into consideration with those animals, which were sacrificed unimproved at an early stage or which showed residual motor disturbances at the time of the follow-up examination, it seems possible that the percentage of completely recovered animals may increase to about 30 per cent at the best.

In addition, the author discusses the possibility of judging the chances of recovery on the basis of the speed of development of the symptoms, the degree of functional disturbances at the height of the attack and finally, the course of the first stage of recovery.

ZUSAMMENFASSUNG

Thorako-lumbale Bandscheibenbrüche mit schwerer Rückenmarkskompression beim Hund.

II. Klinische Beobachtungen mit besonderer Berücksichtigung der Prognose bei konservativer Behandlung.

Die Verfasserin berichtet über Resultate bei konservativer Behandlung von Hunden mit thorakalem oder lumbalem Bandscheibenbruch von solchem Schwierigkeitsgrade, dass die Tiere nicht auf den Hinter-

beinen zu gehen vermochten. Das Material umfasst 141 Hunde, die in der chirurgischen Klinik der Veterinärhochschule in Stockholm behandelt wurden, 94 im Tierspital in Hälsingborg behandelte Hunde und 36 im Veterinärinstitut in Skara behandelte Hunde. Von diesen Tieren genasen 36,9, 45,7 bzw. 47,2 % in solchem Grade, dass sie auf den Hinterbeinen mit oder ohne Bewegungsstörung gehen konnten. Im Stockholmer Material, das einer näheren Analyse unterzogen wurde, gewannen 14,2 % der Tiere innerhalb der vorliegenden Beobachtungszeit *normales* Bewegungsvermögen wieder. Die Verfasserin unternahm einen Versuch, auf der Grundlage der Länge der Beobachtungszeit und des klinischen Verlaufes die Möglichkeiten für eine Genesung der ungebesserten Fälle oder der nicht völlig wiederhergestellten Tiere mit kurzer Beobachtungszeit zu schätzen. Nach dieser Analyse scheint eine Verlängerung der Beobachtungszeit im besten Falle die Anzahl ganz wiederhergestellter Tiere in Stockholmer Material auf zirka 30 % erhöhen zu können. Schliesslich diskutiert die Verfasserin die Möglichkeiten für eine Beurteilung der Prognose auf Grund der Art und Entwicklungsschnelligkeit Wegfallssymptome sowie der Verlaufes der ersten Phase der Genesung.

SAMMANFATTNING

*Thorako-lumbala diskbräck med svår ryggmärgskompression hos hund.
II. Kliniska observationer med särskild hänsyn tagen till prognosen
vid konservativ behandling.*

Författaren redogör för resultatet vid konservativ behandling av hundar med thorakalt eller lumbalt diskbräck av sådan svårighetsgrad, att djuren ej kunnat gå på bakbenen. Materialet omfattar 141 hundar, som behandlats på Veterinärhögskolans kirurgiska klinik i Stockholm, 94 hundar, som behandlats vid Djursjukhuset i Hälsingborg samt 36 hundar, som behandlats vid Veterinärinrättningen i Skara. Av de behandlade djuren ha 36,9, 45,7 resp. 47,2 % tillfrisknat i sådan grad, att de kunnat gå på bakbenen med eller utan rörelsestörande. Inom materialet från Stockholm, vilket material underkastats en närmare analys, har 14,2 % av djuren återvunnit *normal* rörelseförmåga inom den föreliggande observationstiden. Författaren har gjort ett försök att på grundval av observationstidens längd och det kliniska förloppet uppskatta chanserna för ett tillfrisknande för de oförbättrade eller ej helt återställda djur, som haft en kort observationstid. Enligt denna analys synes en förlängning av observationstiden i *bästa fall* kunna öka antalet helt återställda djur inom materialet från Stockholm till c:a 30 %. Slutligen diskuterar författaren möjligheterna att bedöma prognosen med ledning av bortfallssymptomens art och utvecklings-hastighet samt av förloppet på tillfrisknandets första fas.

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