# PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

## THE CONSEQUENCES OF LONGITUDINAL DIVISION OF THE LUMBAR SPINAL CORD IN PUPPIES

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Studies of the immediate and long-term consequences of longitudinal division of the spinal cord have been conducted on birds, frogs, cats and adult dogs [4].

These studies have shown that longitudinal division of the spinal cord in the region of the lumbo-sacral segments, in both birds and adult dogs, results in severe permanent disturbances of standing and locomotion. Some restoration occurred if the division of the spinal cord was only partial in the region of the lumbar segments [6, 7] or if a "bridge" was preserved between the two halves of the spinal cord [4].

The aim of the present investigation was to determine the character of the standing and locomotor disturbances produced by longitudinal section of the spinal cord and the possibility of a restoration of function if the division was performed in sufficiently youthful puppies.

### EXPERIMENTAL METHOD

The experiments were conducted on puppies aged 1½, 2 and 2½ months. Altogether 20 puppies were used. The spinal cords were divided longitudinally from the dorsal side, the scalpel being drawn exactly in the midline. The immediate and remote consequences of the division of the spinal cord were observed by means of systematic observations of how the animals moved, their characteristic poses were photographed, their gaits recorded (ichnograms), the threshold of the bending reflex was found by means of induction currents, registration of responses to such mechanical stimuli as pinching and clipping, as well as thermic and pain stimuli of the extremities was performed and in addition the muscle tonus of the extremities was determined. The conditions of surgery and postoperative care were the same for all the animals.

### EXPERIMENTAL RESULTS

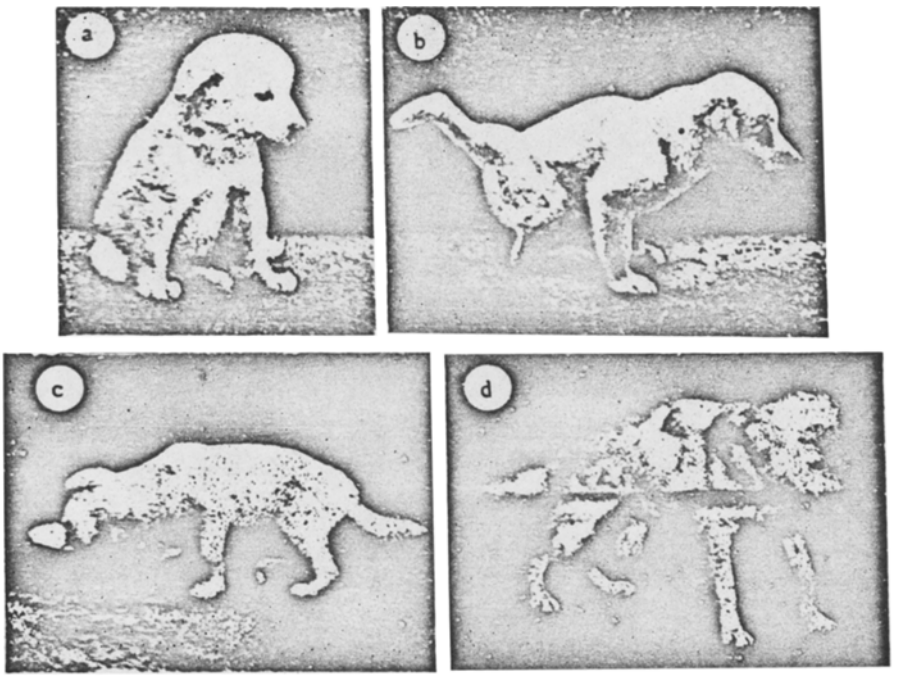
When the spinal cord was divided from the level of lumbar I down to the caudal termination of the spinal cord, there were immediate pronounced disturbances in the functions of the posterior limbs: the puppies were unable to walk or stand. The rear limbs could not be moved. The slightest touch to any portion of the body evoked a definite pain response in the form of a squeal. Mechanical and electrical stimulation of the posterior extremities also evoked a pain response even though the movement responses were very feeble.

Three–four days after the operation the puppies could sit, resting against widely spread fore paws. The pain reaction to mechanical and electrical stimulation of the extremities was much weaker and marked only by a passive flexion and extension of the knee joint. The threshold of the flexion reflex in the posterior extremities stimulated with an induction current was elevated by 3-4 cm as compared with the preoperative period.* With-

*The thresholds were measured with the aid of a Du Bois-Reymond inductorium (in centimeters of distance between the primary and secondary coils).

in 1½-2 weeks after the operation the puppies became able to move again on their fore paws; the rear extremities remaining between the anterior, were somewhat stretched out and directed forward.

About 18 to 25 days following the operation, there could be observed a marked rise in the muscle tonus of all the extremities. In the older puppies, those in the 2 and 2½ month group, at this time there began the development of an extension of the rear limbs and an increased pain response to passive movement of the knee joint. Still later the extension spasm became so great that the posterior extremities tended to remain constantly in a state of extension as a result of which the puppies were unable to stand or walk.




Puppy No. 8 after longitudinal division of the spinal cord at the level of the lumbar thickening (beginning from Lumbar I down to the caudal tip) on the 5th day (a), on the 22nd day (b), after 2 months (c) and after 10 months (d) postoperatively.

A similar operation in the nine dogs aged 1½ months produced disturbances of a somewhat different character. These animals had only a transient, mild pain response to passive movements at the knee and there was no evidence of a severe extensor spasm of the posterior extremities. Muscle tone in these puppies increased only when they attempted to walk on all four extremities. Thirty to forty days post-operatively these puppies were able to walk and run quite well. It is true that their gait was rather different from the normal as they tended to drag their posterior extremities somewhat and did not rest on their toes but on the entire foot up to the ankle joint (see illustrations a, b, c, d). In addition, these puppies had diminished sensitivity of the posterior portion of the body and the rear extremities to thermal, pain and electrical stimuli, this being true of the proprioceptive sensitivity also particularly in the distal portion of the posterior extremities.

Two puppies of this group continued under observation for 10 months after the restoration of the standing and locomotor functions. By that time these puppies were adult animals weighing 9-11 kg. The extent of functional restoration, both motor and sensory, was the same as it had been 1-1½ months postoperatively. All this time the muscular tonus of these two dogs exceeded the normal tonus of intact animals 1½ to 2 times over.

When a "bridge" was left in two puppies at the lumbar level ($L_4$ and $L_5$ segments being left intact), there were no serious functional disturbances to be observed. Three to four days postoperatively these puppies could move quite rapidly with the aid of their anterior extremities and could eat standing on the posterior limbs. By the 10th or 11th day they were walking on all their limbs. By the end of three weeks there was almost full compensation of the standing and locomotor reflexes.

Our data seem to indicate that, differing from the adult dogs [4], 1½ month old puppies can compensate for total longitudinal transection of the spinal cord at the lumbo-sacral level attaining complete restoration of the disturbed standing and locomotor functions of the posterior extremities.

## SUMMARY

The results of longitudinal division of the spinal cord at the level of the lumbar and sacral segments were investigated in puppies aged 1.5 to 2.5 months in a long-term experiment. Considerable disturbances in the hind legs were noted immediately after the operation. The puppies could not stand or walk.

The functions of standing and walking were not reestablished in puppies operated on at the age of two and two-and-a-half months. When the puppies were operated on at the age of one-and-a-half months – recovery took place in 30 to 40 days after the operation.

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