THE PROBLEM OF NEURONAL REGENERATION
IN THE CENTRAL NERVOUS SYSTEM
I. THE INSERTION OF CENTRALLY CONNECTED PERIPHERAL NERVE
STUMPS INTO THE SPINAL CORD*

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To one familiar with the literature in this field, the title of this commu-
nication is much like that used by Le Gros Clark. He attempted
to determine whether the axons of brain neurons would grow into
implanted nerves. He found this action to be limited, but noted that viable
nerve stumps did grow readily into the brain. This finding was verified by
Windle and his associates who ascribed the success of the ingrowth to
inhibition of a hypothetical "glial barrier" by a drug (not used by Le Gros
Clark). Experimental implants were attempted for some time in these lab-
oratories with the tentative conclusion being reached that functionally suc-
cessful ingrowth would be attained if technical problems were overcome.
This is a report of a systematic exploration of the growth and functional
potential of centrally connected peripheral nerve stumps implanted into
the spinal cord.

MATERIALS AND METHODS

Healthy female mongrel dogs weighing from 5.5–16 kg. were operated upon
under pentobarbital sodium anesthesia with ether supplement. Endotracheal
intubation and artificial respiration were used when needed. The operative area
was widely clipped and shaved, following which the region was thoroughly washed and
rinsed. Antiseptic solutions were then applied and the field was outlined with sterile
drapes. Strict aseptic precautions were observed throughout. One or more inter-
costal nerves from above the intended site of transection of the spinal cord were
then isolated after sharply incising the skin and bluntly dissecting the muscles
aside. The nerve was isolated as far anteriorly as the main bifurcation into motor
and sensory branches and as far posteriorly as the paravertebral musculature. After
a midline incision, a laminectomy of the 8th through the 10th dorsal vertebrae was
carried out. A tunnel was created beneath the paravertebral muscles with a Kelly
clamp through which the distally severed intercostal nerve could be brought to
the spinal canal. After careful hemostasis had been established, the dura mater
was opened in the midline and the edges were held apart with traction sutures.

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They moved frequent whereby were passed through the dural edges. When more than one intercostal nerve was to be implanted this same procedure was repeated. The dura mater was then closed tightly with interrupted black silk sutures (5–0) and the wound was closed in layers with silk sutures. Sterile dressings were applied and the animal was afforded detailed postoperative attention and care, with prompt action being taken to correct any untoward developments such as inability to void. This was the procedure utilized in 30 dogs as the initial operation.

In 16 dogs, the spinal cord was transected either before the nerves were implanted as a separate procedure or at the same time. In the remainder, the transection was carried out some time after the implants were placed. The laminectomy was extended superiorly somewhat, being careful not to get too high so as to avoid the region of origin of the implanted intercostal nerves or the site from which they were to be taken. A blunt nerve hook was passed beneath the spinal cord and its investing membranes. The structures were lifted free of the canal and a sharp scissors was used to sever the entire circumference. The severed spinal cord could then be probed, and the completely divided stumps were inspected and pushed apart if they had not already retracted.

In several animals, the previously severed spinal cord was re-exposed at subsequent operations and a section of the tissue measuring from 2 to 4 mm. was removed for study.

Postoperatively, the animals with transected spinal cords were afforded detailed care as outlined above, including periodic night and day evacuation of the bladder. They were exercised daily. Careful attention was given to eating habits and any intercurrent infections were attacked vigorously with appropriate therapy. Each animal received a 2-week course of daily intravenous injections of 1 gamma per pound of body weight of a nonprotein pyrogenic agent of bacterial origin* starting the day after the implantation of the intercostal nerves. In addition, each animal received Roentgen therapy in the amount of 2000 r skin dosage delivered over the area of implantation.

Daily attention was given to the pattern of development of reflex activity and other function. Motion pictures were taken of representative animals at intervals. Special note was made as to the advent of reflex standing and similar phenomena. Voluntary activity was carefully watched for and recorded.

Surviving animals were sacrificed at varying intervals. Under a variety of

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