Effect of Donor Cerebrospinal Fluid on the Recovery of Motor Function in Rats After Partial Decortication

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The ability of donor cerebrospinal fluid from different sources the recover motor functions in partially decorticated rats is estimated. Cerebrospinal fluid from frogs, which have no cortex, and cerebrospinal fluid from donor rats obtained immediately or long after decortication hampers normal recovery of motor function in the recipient rats, while cerebrospinal fluid from intact adult or neonatal rats slightly decreases behavioral manifestations of the motor cortex damage in the recipients.

Key Words: *motor cortex; partial decortication; recovery of motor function; cerebrospinal fluid*

Suboccipitally injected peptide fractions of cerebrospinal fluid (CSF) or brain extract from an animal with model asymmetric central motor disorders caused by unilateral removal of the motor cortex induces in intact recipient the symptoms similar to those observed in the donor [1]. Peptides from the brain of animal with recovered motor function eliminate pathological asymmetry in recipients with such motor disorders in the acute phase [2]. It was shown that injection of brain extracts from animals with compensated cortical damage into animals 2-6 days after a similar cortical damage accelerates motor function recovery in the recipient [2,4]. However, CSF from compensated animals administered 24 h after cortical damage slowed the recovery of motor function in the recipients, whereas CSF from animals with acute cortical damage optimized the recovery process [3].

In the present study we examined the effects of CSF from different donors obtained immediately or long after decortication and CSF from neonatal rats on motor function recovery in partially decorticated recipient rats.

MATERIALS AND METHODS

The recipients were random-bred male albino rats weighing 180-200 g. In all recipients, the zone representing the right hind limb and partly the right forelimb in the motor cortex of the left hemisphere was removed by aspiration under hexenal anesthesia. This removed zone had the following boundaries (mean values): A = 2 mm, P = 4 mm, and L = 0.5-4 mm from the bregma. Six experimental series were performed, using 8-10 rats per series. In series I-V, rats received 50 μl CSF taken from donor animals and contained in the sponge by which the aspirated cerebral tissue was replaced. In rats of series VI (controls), the sponge replacing the aspirated tissue contained no CSF. Donors were intact 2-day-old rats in series I, intact adult rats in series II, adult frogs in series III, and adult rats 3 days and 4.5 months after decortication (similar to that performed in the recipients) in series IV and V, respectively. Cerebrospinal fluid was obtained by puncturing the great occipital cistern. All operated recipients were tested for supportive function by measuring the distance between the first and the fifth fingers of the hind limbs in rat maintained in the upright posture (a modification of Hasegawa's method [7]); 10 measurements were made in sequence for each animal, and the mean value and 95% confidence interval were calculated for a given day for the whole series. These tests were continued to postoperative day 35. The recipients and donors were then killed by overdosage of anesthetic, and the damaged area in the brain was verified morphologically (Fig. 1).

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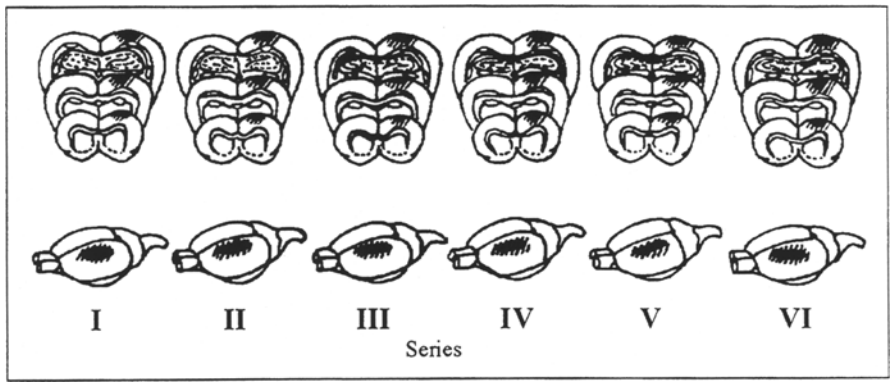

Fig. 1. Schematic drawing of frontal brain sections showing zones of maximal and minimal cortical extirpations in each series (top) and schematic representations of their total size (bottom).

RESULTS

As previously [4], posttraumatic abnormalities were observed in all rats. The distances between the right limb fingers (damaged cortical projection) decreased (Fig. 2). The abnormalities were minimal in series VI (control), I and II, more severe in series III and IV, and the most severe in series V. On postoperative day 1, the differences between the parameters for the right and left paws were the greatest in series V and VI. The earliest recover of motor function (postoperative day 3) was observed in series II. In series I and II, a secondary abnormality ("overcompensation"): significantly better performance of the right than the left limb, was noted 2 weeks after operation; in control rats the difference was insignificant. Asymmetry persisted for about 10 days or longer in series III and IV and almost throughout the entire observation period (about 30 days) in series V.

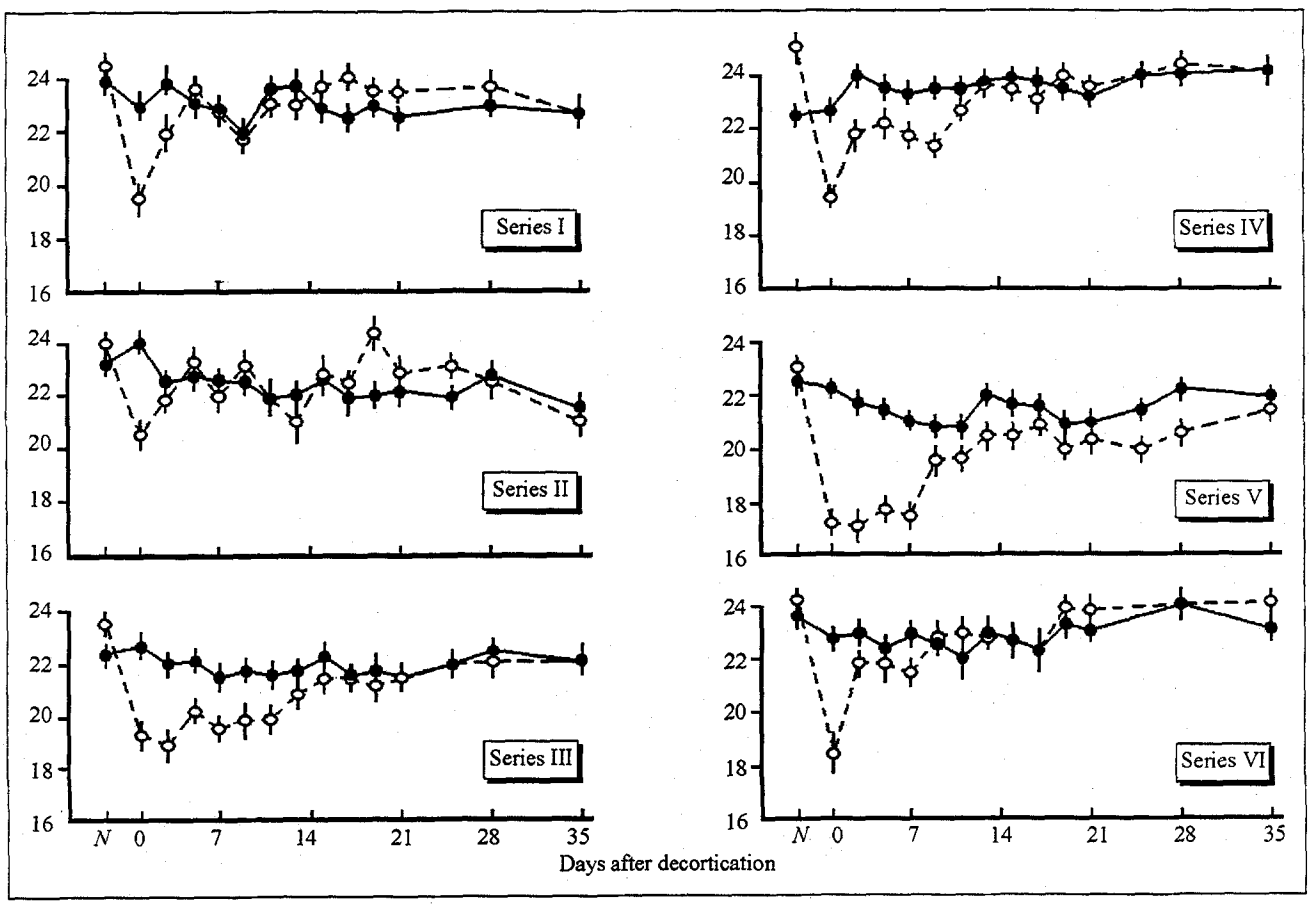

Fig. 2. Distance between the fingers of the hind limbs in intact (*N*) and partially decorticated rats. Ordinate: distance in mm for the first and the fifth fingers. Dashed line: right limb contralateral to cortical damage; solid line: limb ipsilateral to cortical damage. Thin bars at the curves represent 95% confidence interval.

Thus, the results obtained in control rats did not differ considerably from our previous findings [4,5]. The effect of CSF from intact donors depends on their corticalization. The effect of CSF from adult rats was similar to that of CSF from neonatal rats and manifested itself as a shortening of acute postoperative period. In 2-day-old rats, both the bodies and processes of cortical motor neurons have already formed, but synaptic junctions are inadequate [6], i.e., these rats are not corticalized in the functional sense. Introduction of neural graft into the cortical accelerates motor recovery, and the significance of biochemical substances contained or produced by this graft has been discussed [8]. This finding suggests that CSF applied onto damaged brain area acts as a "minigraft." Cerebrospinal fluid from frogs, which have no motor cortex, prolongs postoperative abnormalities in the recipient rats.

Cerebrospinal fluid of experimentally decorticated rats (series V and VI) induced more pronounced abnormalities in the recipients compared with the controls, particularly if the CSF was obtained 4.5 months after surgery and the recipients had already developed functional compensation. This result agrees with previous studies [3,4] which showed that the CSF from operated donors has a favorable effect on the posttraumatic process in the recipients only when it was administered at optimal terms.

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