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Distribution of bilateral dorsal root potentials evoked by volleys in afferents entering lumbar and sacral segments of the spinal cord

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Summary. Ipsilateral dorsal root potentials evoked by volleys entering lumbar and sacral segments of the cord are largest at the level of entry of afferent volleys. Contralateral potentials resulting from stimulation of any of these nerves attain maximum amplitude in lower sacral and upper caudal segments.

The dorsal root potentials (DRPs) reflect depolarization of the central terminals of primary afferent fibers. It is considered that they indicate presynaptic inhibition, which controls the influx of sensory impulses into the cord[1-3]. The depolarization is produced in the immediate neighborhood of the place where the afferent volley enters the spinal cord and then it spreads to more distant segments. We have studied the DRPs produced by stimulation of L5 and Ca2 dorsal roots and recorded in 6 segments lying between them. In these experiments the DRPs evoked by volleys in each dorsal root were recorded after their spread in only one direction. It was found that ipsilateral potentials spreading caudally decrease to a smaller extent than the DRPs spreading cranially. On the contralateral side the DRPs transmitted cranially do not differ from ipsilateral potentials while depolarizations spreading caudally increase in segments close to the stimulated dorsal root[4]. These observations suggest that the effect of presynaptic inhibition on sensory information reaching more distant parts of the cord depends on the direction of spread and on the level of entry of afferent volleys. To obtain more insight into this question in the present experiments we investigated the longitudinal distribution of bilateral DRPs spreading in both directions. They were produced by volleys in peripheral nerves entering lumbar and sacral segments of the spinal cord.

Material and methods. The experiments were performed on 24 cats. Under short-acting thiamylal sodium anesthesia (25 mg/kg) the common carotids were tied and the animals were decerebrated at intercollicular level. After exposing the spinal cord the most caudal rootlets of equal thickness were separated bilaterally from 6 dorsal roots (L6 through Ca1) and prepared for recording the DRPs. 4 nerves; posterior tibial, superficial peroneal, caudal femoral cutaneous and pudendal were mounted on one side on the stimulating electrodes. The DRPs were produced by single pulses lasting 0.1 msec at 4 times the threshold strength.

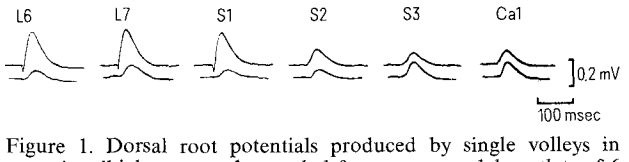

Figure 1. Dorsal root potentials produced by single volleys in posterior tibial nerve and recorded from most caudal rootlets of 6 consecutive dorsal roots. Upper trace of each record shows ipsilateral and lower trace contralateral potential. Symbols over records indicate the level of recording.

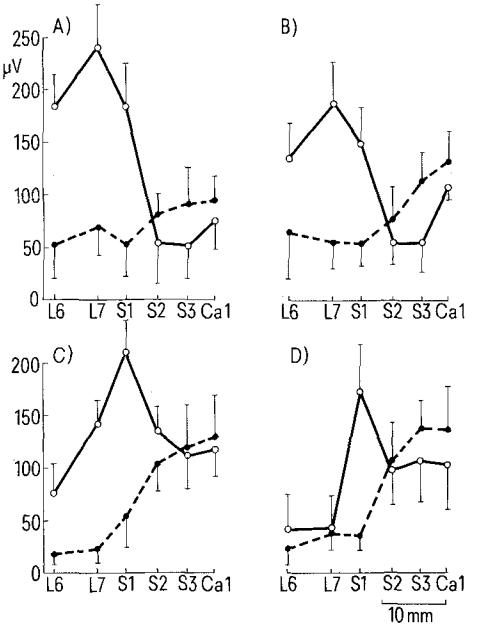

Figure 2. Distribution of the dorsal root potentials evoked by single volleys in posterior tibial (A), superficial peroneal (B), caudal femoral cutaneous (C) and pudendal (D) nerves and recorded from the most caudal rootlets of 6 consecutive dorsal roots. The distances between points of entry of dorsal rootlets into the cord are plotted as abscissae and the mean sizes of potentials as ordinates. Open circles show ipsilateral and closed circles contralateral potentials. Each point represents the mean ± SEM of 12–16 experiments.

Results and discussion. The records of figure 1 show that the DRPs evoked by stimulation of posterior tibial nerve vary in amplitude in consecutive segments of the cord. Ipsi-potentials are large in cranial segments of the studied part of the cord (L6–S1) and become smaller in more caudal segments (S2–Ca1). Contralateral depolarizations are increased in records taken in 2 lowermost segments of the cord.

The mean sizes of the DRPs elicited by stimulation of posterior tibial and superficial peroneal nerves are illustrated in figure 2, A and B. These 2 nerves enter the cord through lower lumbar dorsal roots. It may be seen that in both instances ipsi- DRPs attain maximum amplitude in L7 segment. In neighboring segments (L6 and S1) potentials are decreased to approximately the same level. Their most rapid reduction occurs between S1 and S2 segments. Potentials in S2 and S3 segments are significantly lower than those in L7 dorsal roots ($p < 0.05$). In lower sacral segments the size of potentials ceases to diminish and in Ca1 dorsal root some enhancement of the DRPs is observed. Contralateral DRPs are small in the 2 last lumbar and the 1st sacral segments. Then they increase, but differences between the smallest and the largest potentials do not attain the level of statistical significance ($P > 0.05$). Figure 2, C and D, shows amplitudes of the DRPs evoked by volleys in caudal femoral cutaneous and pudendal nerves which enter the cord via sacral dorsal roots. In both cases the maximum sizes of ipsi- DRPs are in S1 dorsal root and are thus shifted one segment caudally as compared with those seen in figure 2, A and B. In neighboring segments a marked decrease of potentials is observed. It is smaller in caudal than in cranial parts of the portion of the cord studied. Only ipsi- DRPs to volleys in the caudal femoral cutaneous nerve are significantly higher in the S1 segment than in the L6 segment of the cord ($p < 0.05$). Contralateral potentials are very small in lower lumbar segments and increase markedly in lower sacral and Ca1 segments, the differences between depolarizations in L6 and Ca1 dorsal roots being statistically significant ($p < 0.05$). It should be noted that in all compared instances the largest ipsilateral DRPs are significantly higher than contralateral potentials in the same segments of the cord ($p < 0.05$).

The extent of spread of ipsi- DRPs to volleys in the superficial peroneal nerve cannot be directly compared with the findings of Carpenter et al.[5] who evoked potentials with lower stimulus strengths and recorded them in close proximity to the entry zone of this nerve. Differences between the present findings and our previous studies[4] are most probably due to the fact that in the latter instance the DRPs were elicited by stimulation of the dorsal roots in spinal animals. Our present results show that for each nerve the peak amplitudes of ipsi- DRPs correspond to the largest field potentials which in general conform to the levels of entry of afferent volleys into the cord[2,5–9]. In contrast to these data the distribution of contralateral DRPs does not show any relationship with the entry levels of afferent volleys. The enhancement of contralateral depolarization in S2–Ca1 segments which occurs irrespective of nerves employed for their elicitation indicates a very fixed pattern of depolarization in successive segments of these parts of the cord. There is evidence that the DRPs spread with different velocities on both sides of the cord and that temporal facilitation of potentials traveling caudally is larger on the contralateral than on ipsilateral side of the cord[4,10]. It has also been postulated that ipsilateral DRPs which spread in the caudal direction are transmitted to the contralateral side in several segments below the zone of entry of afferent volleys. It is conceivable that these factors may increase the size of the DRPs elicited by single volleys and spreading to the lower sacral and upper caudal segments of the spinal cord. The distribution of bilateral DRPs and hence of presynaptic inhibition may have functional significance. Sensory information received by L6–S1 segments originates from paired structures displaying antagonistic activity (hind legs) while that reaching S2–Ca1 segments comes mainly from non-symmetric organs (urethra, anal canal etc.). We suggest that differences between the level of ipsilateral and contralateral presynaptic inhibition in L6–S1 segments, together with similar inhibition on both sides of S2–Ca1 segments, are required for proper regulation of the activity of the structures innervated by both parts of the cord.

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Are plant toxins aimed at decomposers?

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Summary. Secondary plant substances may regulate the rate of decomposition. Evidence from many quarters suggests that this may be one of their primary ecological roles.

The widespread distribution of secondary plant substances in natural systems is well known. These are almost always interpreted as being defences by plants against herbivores and pathogens[1–7]. However, they are also effective against decomposers[3,8–11], and since the flow of organic matter through the decomposition subsystem is many times larger than that through the herbivore subsystem, in almost all ecosystems[8], the greatest quantitative effect of plant toxins is against decomposition. Such an effect on decomposition has been interpreted as secondary fallout from the battle