206

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ASCENDING AND DESCENDING BRAINSTEM NEURONAL ACTIVITY DURING CYSTOMETRY IN CATS

Aims of Study

The pontine micturition center (PMC), where electrical stimulation evokes micturition, corresponds to the nucleus locus coeruleus alpha (LCa) in cats [1]. Electrical stimulation of the nucleus locus subcoeruleus enhances external urethral sphincter activity and inhibits bladder contraction. The third pontine region controlling lower urinary tract function is located ventromedial to the locus coeruleus complex. Electrical stimulation of this region inhibits bladder activity, and this region corresponds to the nucleus reticularis pontis oralis (PoO) [2]. From the LCa and the PoO, there are axonal projections to the spinal cord and the rostral medullary area including the nucleus reticularis magnocellularis (Mc) or the nucleus reticularis gigantocellularis (Gc) [3, 4]. These findings suggest that rostral medullary neurons are involved in the micturition reflex or in controlling urine storage. The present study was undertaken to examine the distribution of rostral pontine and rostral medullary neurons related to micturition or urine storage by using extracellular recording and cystometry, as well as the connections between the PMC, medullary neurons, and the spinal cord.

Methods

Twenty-one adult cats of either sex were used. Under halothane anesthesia, two catheters were inserted through the bladder dome to perform cystometry. After closing the abdomen, the first lumbar segment (L1) of the spinal cord was exposed, and bipolar electrodes were placed on the surface of the L1. After craniotomy, a decerebrate state was created by transection at the precollicular-postmammillary level. Anesthesia was discontinued after decerebration. A microelectrode was systematically inserted into the rostral pons (Horsley-Clarke coordinates, P 0 to 4, LR 0 to 5, H -1 to -5) or the rostral medulla (P 7 to 9, LR 0 to 4, H -2 to -6) for extracellular recordings of neurons. A search was conducted to locate spontaneously firing neurons and neurons with an antidromic or orthodromic response to L1 stimulation. The responses of medullary neurons to electrical stimulation of the PMC were also recorded. The latencies of the antidromic or orthodromic responses of ponto-medullary neurons to L1 or PMC stimulations were estimated. The PMC was identified as the site where micturition was elicited by electrical stimulation. Firing of the identified units was quantitated with a pulse counter and displayed on a paper recorder along with the bladder pressure monitored during cystometry. Results are reported as the mean ± standard error.

Results

A total of 183 single units was recorded. Ninety-four neurons showed an increase or decrease of the firing rate during micturition. Units with an antidromic response to L1 stimulation and an increased firing rate during voiding were located in the LCa (n = 8) corresponding to the PMC, and in the Gc and Mc of the medulla (n = 14). Units with an antidromic response to L1 stimulation and a decreased firing rate during voiding were located in the PoO (n = 26) and in the Gc and Mc (n = 11). The latencies of antidromic (13.9 ± 0.4 ms) and orthodromic responses (15.8-26.4 ms) of the LCa units to L1 stimulation were longer than those (3.4 ± 0.1 ms and 2.5-15.5 ms, respectively) of the PoO units. Gc and Mc neurons responded antidromically and/or orthodromically to stimulation of the PMC or L1. The orthodromic latency from PMC stimulation to the response of three Mc units showing a increased firing rate, which also responded antidromically to L1 stimulation, was 2.0-3.0 ms. Based on the orthodromic latency (2.0-3.0 ms) of these 3 Mc units after PMC stimulation and the antidromic latency (3.5-12.0 ms) of the same units after L1 stimulation, the total latency (the sum of these two latencies) from PMC to L1 via Mc units was 6.5-14.0 ms (9.7 ± 2.2 ms). This total latency was significantly ($p = 0.0178$) shorter than that (13.9 ± 0.4 ms) from L1 stimulation to the antidromic response of LCa units.

Conclusions

In the rostral pons, descending neurons that showed increased firing and decreased firing

during voiding were located in the LCa and in the PoO, respectively. However, there was no close localization of these 2 types of neurons in the rostral medulla. Since the latencies of antidromic and orthodromic responses of the PoO units to L1 stimulation were shorter than those of the LCa units, the pathway concerned with urine storage has a faster spino-bulbo-spinal loop rather than the micturition reflex pathway. There are two descending pathways for micturition running between the PMC and the spinal cord, a direct one and another via medullary Mc neurons. Rostral medullary neurons also play an important role in micturition and urine storage.

References

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