Identification and characterization of thoracic neural circuits in the mammalian spinal cord

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Introduction: The control of our trunk-related muscles is essential to coordinate locomotion in limbed and limbless animals. Limbless animals can move via a longitudinal coordinated wave of muscle contractions combined with segmental alternating contractions (half-center neural circuit organization). With the evolution of limbs, trunk neural networks had to interact with these new limb-related networks and with sensory feedback to produce fluid movements. Studies have shown that the lumbar network entrains the thoracic network during locomotion suggesting a passive role of this trunk-related circuitry. We hypothesize that the trunk-related circuitry can have a principal role during posture and locomotion.

Methods: We performed electrophysiological experiments on mouse thoracic and/or lumbar spinal cords form neonatal mice. We conducted extracellular ventral root recordings to assess the effects induced by neurotransmitters known to elicit locomotor activity in lumbar cords.

Results: Our results show that the thoracic cord coordinates with the lumbar cord during locomotor-like activity displaying a motor output with similar temporal dynamics (parameters). More interestingly, the isolated thoracic spinal cord can produce synchronous or alternating patterns of motor activity independent of lumbar (limb-related) neural networks and the motor output displays much slower temporal dynamics suggesting postural/balance-related control of movement. Alternating activity was elicited in the presence of a high-divalent solution suggesting that this rhythmic output was mostly coordinated through monosynaptic connections. Moreover, the use of blockers for inhibitory neurotransmission (strychnine and picrotoxin) disrupted this rhythmic alternating pattern.

Conclusions: These findings support our overarching hypothesis that trunk-related motor output is at least partly produced by a half- center circuit organization which is likely evolutionarily conserved from limbless vertebrates.

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