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Editorial

Treadmill training after spinal cord injury

Good but not better

Jonathan R. Wolpaw, MD

In theory, a good experiment is supposed to be a multiple-choice question with only a few well-defined possible answers. In fact, the outcome of the most productive experiments is frequently "None of the above." The study in this issue of *Neurology* by Dobkin et al.[1] is an excellent example of a well-designed study with an outcome substantially different from any of those anticipated.

In 1951, Shurrager and Dykman[2] reported that training could restore locomotion after spinal cord transection in cats. However, it is only in the past 20 years that this phenomenon has been vigorously explored, in concert with the growing recognition of the spinal cord's considerable capacities for plasticity and of other new possibilities for restoring function after spinal cord injury.[3-7] Motivated by the impressive evidence of the impact of treadmill training in spinalized animals, and by largely uncontrolled human studies suggesting that similar training could greatly improve walking after partial spinal cord injuries, Dobkin et al.[1] set out to test the hypothesis that body-weight supported treadmill training (BWSTT) is more effective than conventional rehabilitation (standing/stepping training) for restoring locomotion after partial spinal cord injury. In a tightly controlled single-blind, multicenter trial, they compared BWSTT to a control regimen (CONT). The two regimens devoted equal time to mobility training. They differed in that the BWSTT regimen divided this time between treadmill training and conventional standing/stepping training, while the CONT regimen devoted all the time to conventional standing/stepping. The data, which are from patients with a variety of injuries and varying degrees of disability, are necessarily complex. Their implications are nevertheless clear.

The BWSTT and CONT regimens were indistinguishable from each other in their ability to restore locomotion. There were no differences between them in any of the functional measures. As the authors note, this answer applies directly only to the initial months after injury, and not to the chronic phase from which much of the encouraging uncontrolled data have come. Nevertheless, it dampens the hope that BWSTT can provide rehabilitation substantially superior to that possible with standard methods. Instead, BWSTT simply adds to the armamentarium of similarly efficacious rehabilitation options. This sobering result reaffirms the critical importance of well-controlled properly blinded studies, particularly for resolving issues involving prolonged interventions for complex long-term disorders.

At the same time that it lowers the expectations for BWSTT, the study provides unexpected encouragement. The therapeutic effects, for both BWSTT and CONT groups, were much better than expected from available evidence. This was particularly true for ASIA C patients (some motor function below the injury, most key muscles graded <3 of 5[7]). Many more regained walking than past evidence indicated would do so. Thus, this study implies that different rehabilitation regimens can achieve good results if they are properly focused on a defined objective and are vigorously pursued. It also highlights the fact that the course of disability after spinal cord injury remains poorly defined. There is continuing need for careful large studies charting the natural history of disability after spinal cord injury in the context of prevailing acute and chronic rehabilitation programs.[8,9] This information is needed both as a guide for identifying key research areas and for designing effective studies, and as a baseline for evaluating the outcomes of new therapeutic approaches.

Finally, this study joins the rapidly growing body of clinical and laboratory evidence attesting

See also page 484

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to the ubiquity and importance of activity-dependent plasticity in the nervous system. While plasticity is most evident during development, it continues throughout life and plays a major part, for good or ill, in determining the functional outcomes of chronic disorders such as spinal cord injury.[3] The efficacy of rehabilitation methods depends to a large extent on their success in engaging and guiding such plasticity so as to restore useful function. This dependence will only grow further as the induction of significant regeneration becomes possible and creates the need for methods to shape restored connections so that they support effective function. The results of Dobkin et al.[1] suggest that different interventions, when assessed for a population as a whole, can attain more or less comparable results: BWSTT and conventional locomotor training had similar average outcomes. At the same time, animal studies indicate that certain minimal conditions must be met and also suggest that individual patients can be best served by tailoring interventions to target their specific functional deficits.[3-6,10]

In sum, although Dobkin et al.[1] give a negative answer to the question their study was designed to address, it is an important and ultimately successful study, for it reaffirms the importance of controlled experiments, highlights major gaps in current knowledge, and will help guide the design, implementation, and assessment of new treatment methods.

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