DISCUSSION

Effects of Hyperbaric Oxygen on Peripheral Nerves

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Dr. Eguiluz-Ordoñez and colleagues publish their experience with 40 rats, divided into four groups of 10. All rats underwent sharp sciatic nerve transection and repair (interfascicular and epineural) followed by various lengths of follow-up. Two of the groups were euthanized at 7 weeks, with half being treated with hyperbaric oxygen twice daily for 10 days at 2.0 atmospheres (absolute) at 90 minutes per dive. The treatment began within 3 hours of the sciatic nerve transection. The other two groups were euthanized at 14 weeks, with half being treated with hyperbaric oxygen using the same protocol as above. The authors found a statistically significant improvement in the rats treated with hyperbaric oxygen versus nontreated rats. Specifically, they found an increase in the number of regenerating axons and capillaries/arterioles at 7 weeks and a better functional recovery at 14 weeks as measured by improved foot-ankle angles and reinnervation by electromyography.

The available literature on hyperbaric oxygen is steadily increasing. Teleologic arguments drive the studies, as there is no dispute that tissue oxygenation is improved with hyperbaric oxygen, provided the peripheral vascular system is healthy enough to transmit the increase in oxygen content to the end organs. The question becomes, *Does this make any difference in functional outcomes?* This study attempts to answer this question with respect to peripheral nerve regeneration.

The study is well executed and uses standard protocols in sciatic nerve transection in the rat model. The histologic, neurophysiologic, and morphometric studies are appropriate as measurable endpoints. The improvements in regeneration are noted. As above, the question remains though, *Does it make any difference in functional outcomes?* The answer according to this study would have to be no. Although the authors use foot-ankle angles as indicators of functional improvement and find improvement at 7 weeks (57.5 degrees in nontreated versus 45.5 degrees in treated) and at 14 weeks (68 degrees in nontreated versus 57.2 degrees in treated) (indicating less foot drop in those treated with hyperbaric oxygen), no analyses were performed on these measurements to determine their statistical significance. As such, the reader has difficulty in attempting to discern the importance of the authors' findings. In addition, the sciatic functional index was not used in this study, which is a well-described objective index of integrated motor and sensory function.[1] Perhaps the most important component of this index, gait analysis, was not performed in this study, and would have been helpful—especially when attempting to compare this study to the many other published studies that use the sciatic functional index. Furthermore, comparison to the uninjured leg in each rat may be helpful to serve as an "internal control" to verify the results both within the same animal and between groups of animals.

In the literature, there are multiple other authors who have performed similar studies and have found no difference in functional results after treatment with hyperbaric oxygen with respect to peripheral nerve injuries.[2–4] Some of these studies use crush techniques and are therefore a different type of injury than what Eguiluz-Ordoñez and colleagues are examining in this experiment. Others, however, use sharp transection with repair with similar dive parameters and lengths of follow-up and therefore can be directly compared. These studies have shown no statistically significant improvement in functional outcomes. Many use maximal muscle tetanic force measurements and reinnervated muscle weights as endpoints. Others use walking track analyses with toe-spreading measurements. In any case, the common denominator seems to be that the functional outcomes are not improved, even though histologic and morphometric analyses demonstrate improvement in axonal regrowth, angiogenesis, and muscle weights. An exception to this is a study by Zamboni et al. that found functional improvement in rats on walking track analysis after sharp sciatic nerve transection, repair, and hyperbaric oxygen.[5] It should be noted that they stripped the extrinsic blood supply in their study, whereas this was not performed in the

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experiment by Eguiluz-Ordoñez et al. The differences warrant further study. Overall, however, teleologic arguments seem to be stronger than the actual objective evidence.

Finally, the authors point out that at 14 weeks, no hyperbaric oxygen–treated rat was found to be completely denervated on electromyography. The differences between the hyperbaric oxygen–treated group and nontreated group, however, did not show statistical significance at this 14-week point, even though it was significant at 7 weeks.

The most that can be inferred from this study is that hyperbaric oxygen has conclusive effects on axonal regrowth and angiogenesis in the early postinjury period after peripheral nerve injury. This is a reaffirmation of previously published data.[6–10] The minimal amount of hyperbaric oxygen necessary to achieve this is not known and, more importantly, definitive functional improvement as a result of these positive effects has yet to be conclusively and reproducibly demonstrated in vivo. Obviously, further study is still warranted when it comes to elucidating the role of hyperbaric oxygen in nerve-injured patients.

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