A Novel Paraplegia Model in Awake Behaving Rhesus Macaques

Max Ostrinsky Krucoff MD; Katie Zhuang PhD; David MacLeod MD; Allen Yin BS ME; Yoon Woo Byun BS BA; Dennis A. Turner MA, MD; Laura Oliveira MD; Mikhail Lebedev PhD

Duke University Medical Center

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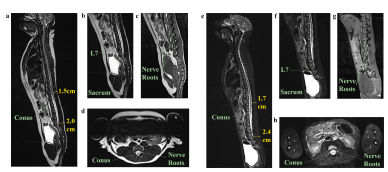
Introduction

Lower limb paralysis from spinal cord injury (SCI) or neurological disease carries a poor prognosis for recovery and remains a large societal burden. Neurophysiological and neuroprosthetic research have the potential to improve quality of life for these patients; however, the lack of an ethical and sustainable non-human primate model for paraplegia hinders their advancement. Therefore, our multi-disciplinary team developed a way to induce temporary paralysis in awake behaving macaques by creating a fully implantable lumbar epidural catheter-subcutaneous port system that enables easy and reliable targeted drug delivery for sensorimotor blockade.

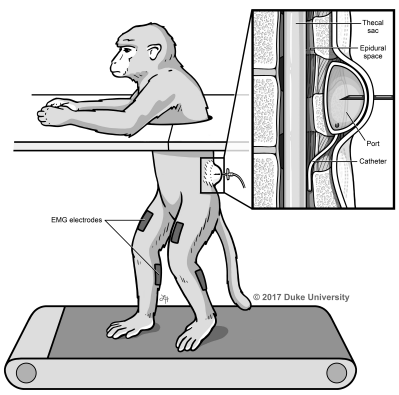
MRI of a female (a-d) and male (e-h) rhesus macaque.



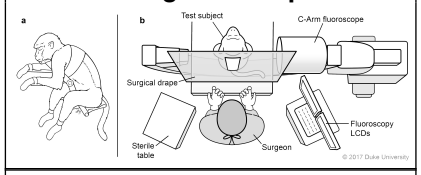
Methods

Three adult rhesus macaques were implanted with an epidural catheter placed at L4-5. Aliquots of 1-2% lidocaine with and without 1:200,000 epinephrine were percutaneously injected into the ports while surface EMGs recorded muscle activity from the quadriceps and gastrocnemii during treadmill walking.

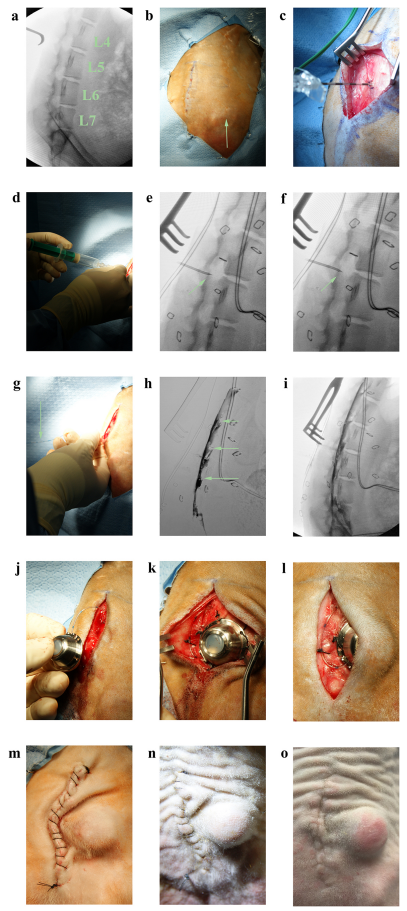
Treadmill and EMG experimental setup



Surgical Setup



Epidural Port Implantation

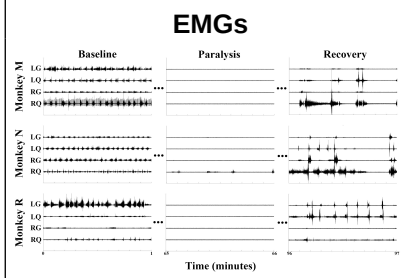


Results

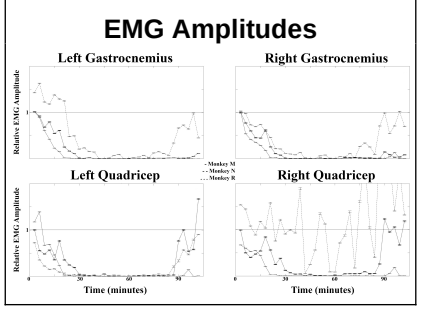
Diminution of EMG amplitude, loss of voluntary leg movement, and inability to bear weight were achieved for 60-90 mins in each animal, followed by a complete recovery of function.

Paralysis Trials

EMGs



EMG Amplitudes



Conclusions

We believe this model will lead to important advancements in the study of how the proximal central nervous system (CNS) responds to acute injury, maintenance of paralysis, and recovery of function. Additionally, it should aid in the development of many lower extremity neural interfacing paradigms, as now the neurological function of chronically implanted macaques that have extensively trained for this type of neural interface work can be preserved while developing these techniques. Furthermore, the temporary paraplegia achieved here is done so in an ethical, sustainable, and non-painful manner – especially when compared to current models of paralysis.

References

1) M.O. Krucoff, K. Zhuang, D.B. Macleod, A. Yin, Y.W. Byun, R.J. Manson, D.A. Turner, L. Oliveira, M.A. Lebedev. "A Novel Paraplegia Model in Awake Behaving Macaques." Journal of Neurophysiology. July 2017.

2) M.O. Krucoff, S. Rahimpour, M. Slutzky, R. Edgerton, D. Turner. "Enhancing Nervous System Recovery Through Neurobiologics, Neural Interface Training, and Neurorehabilitation." Frontiers in Neuroscience. December 2016.