1. INTRODUCTION

Complete Spinal Cord Injury (SCI) Model at T10

Neonatal Transaction (NTX) (Post-natal day 56)

Adult Transaction (ATX)

Autonomous Stepping

NO Autonomous Stepping

Weight Support (WS) 50% of body weight provided by the robot (B).

Non-weight Support (NWS) 10% of body weight provided by the robot (B).

TRUNK ROBOT REHABILITATION

Significant Improvement in locomotor function ON robot.

NO significant improvement in locomotor function ON robot.

2. ROBOT REHABILITATION

Cantilevered Phantom haptic robot (SensAble Devices Inc.) attaches via surgically implanted pelvic orthosis and applies isotropic elastic force fields (stiffness k = 45 N/m) at the pelvis during treadmill locomotion for 20 mins/day, 5 days/week, 4-8 weeks.

3. PRELIMINARY DATA: Recovery of Locomotion in Two SCI Models with Robot-Assisted Rehabilitation

• ATX rats without any additional stimulation (perineal or epidural) fail to improve function with robot rehabilitation.
• NTX (non-W5) rats and ATX Rats with robot-driven epidural stimulation show significant improvement in locomotor function on robot as seen through an increase in functional kinetic recovery scores (A) and decrease in vertical % BWS (body weight support) provided by the robot (B).

4. EXPERIMENT

Experimental

Complete adult SCI (T9/10) (n=8)

Control

Complete adult SCI (T9/10) (n=8)

AAVS-BDNF Injection 1 mm caudal to injury

AAV5-GFP injection 1 mm caudal to injury

Robot Training (20 mins/day; 5 days/week; 4-6 weeks)

Robot Training (20 mins/day; 5 days/week; 4-6 weeks)

5. METHODS

AAV5-GFP is an Adeno-associated virus-5 that produces Green Fluorescent Protein (GFP) when expressed

zForce R

Thoracic Tx

C

Four microinjections of 2 µl were injected following the pattern above

Total 8 µl of virus: 2.5 x 10^6 viral particles

Saline (Control)

AAV5-GFP (Experimental)

6. RESULTS

AOB Scores of BDNF Rats

Changes in AOB score with Robot Training

Changes in % BWS with Robot Training

Start and End of Training

We observed significant improvement in locomotor behavioral scores in ATX rats treated with combined robot rehabilitation and AAVS-BDNF after training.

Percent Weight-Supported Stepping

• Control group (n=5): No animals developed any weight-supported stepping (WSS).
• Experimental Group (n=8): All animals began with 0% WSS
  • 5 of 7 were able to provide > 5% WSS
  • Average final %WSS: 43.73 ± 13.07 %WSS (three animals were above 75%)

Significant improvement in %WSS between control and experimental* and within the experimental group **.

7. CONCLUSIONS

ATX animals treated with AAVS-BDNF demonstrated significant locomotor recovery compared to those treated with AAV5-GFP. We found significant improvement in animals treated with BDNF in these three outcome measures:

1. AOB: BDNF animals showed significant improvement in overall score, with score level indicating increased weight-support, right-left hind limb alternation, and plantar foot placement.
2. Robot Force: BDNF animals showed a significant decrease in use of robot forces, indicating increased body weight support.
3. %WSS: BDNF animals exhibited a significant increase in the percentage of the number of steps they took that were weight-supporting. The pattern of recovery also closely resembled patterns of AOB recovery.

Combining varied methods to improve locomotor recovery in treating SCI may result in synergistic effects that may provide more robust recovery.

The increased excitability of the spinal cord from viral delivery of BDNF coupled with robot training has potential to create new avenues of combined therapy to treat SCI.

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