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CREATING A DEVELOPMENTAL SPINAL STENOSIS RAT MODEL AND UTILITY OF SOMATOSENSORY EVOKED POTENTIAL FOR TESTING

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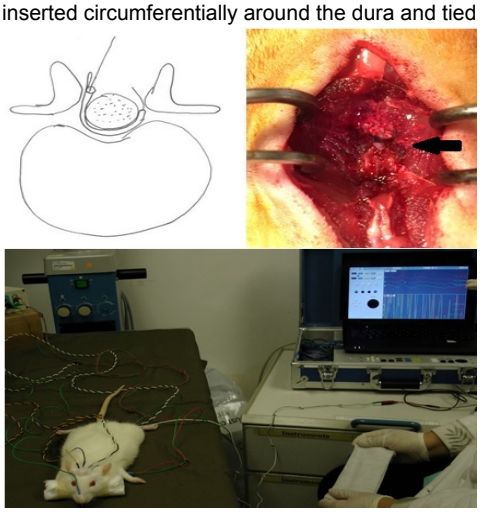
Introduction: Developmental Spinal Stenosis (DSS) is defined as a pre-existing narrowed spinal column originating from the mal-development of dorsal spinal elements, hence resulting in a reduction of space to accommodate the spinal cord and nerve bundles. It is characterized by a circumferential narrowing of the bony canal. A representative rat circumferential compression model has been created to simulate this pathology for behavioral, neurophysiological and histological testing.

Methods: Ten female 13.0 to 14.5 weeks-old Sprague-Dawley rats were randomly divided into the following groups: circumferential compression using stainless-steel wire and silicone sheets, dorsal compression using silicone sheets and control. Laminectomy at L4-L5 was performed. Either 28-gauge stainless steel wire or the silicone sheet (0.51mm thick) were inserted circumferentially around the dura and tied at the dorsal aspect (**Figure**).



For dorsal compression, two overlapping silicone sheets were used to compress only on the dorsal aspect of lumbar spinal cord to simulate the usual pathology of degenerative spinal stenosis. Controls only had exposure of the dura without any compression device. All rats were assessed preoperatively, and at postoperative 1-week, 2-weeks, 3-weeks, 1-month and pre-sacrificing (Sacrifice at 2 months postoperatively). Assessment included behavioral and locomotion tests (rung ladder walking, swimming), electrophysiological tests, and histological analysis of the degree of axonal demyelination of neural tissues.

Results: For horizontal rung ladder test, the average Basso, Beatie and Bresnahan (BBB) score at pre-sacrificing was: 8 (circumferential), 14 (dorsal compression) and 16 (control) ($p<0.05$). The average Louisville Swimming Scale (LSS) for the swimming test at pre-sacrificing was: 1 (circumferential – wire), 2 (circumferential – silicone), 4 (dorsal compression) and 7 (control). Strong correlation between BBB and LSS score was observed. The circumferential group, whether by stainless-steel wire or silicone sheet, caused little or no hindlimb movements not only on walking, but also in swimming with demonstrable high reliance on forelimbs for forward motion in the water. The circumferential compression group using silicone sheets was the only group with increasing trend of latency at both P1 and N1 for both hind-paws, and consistently higher latency than the dorsal compression group. The axon/myelin areas ratio was the largest for circumferential compression group (0.78) as compared to dorsal compression group (0.68) and controls (0.39).

Discussion: This study has successfully demonstrated the use of somatosensory evoked potential to test for increased latency in a novel DSS rat model. The model was sufficient in causing axonal demyelination. Further validation with decompression tests can be tested in subsequent work.

Figure: schematic diagram of circumferential compression (top left), intraoperative compression device (top right), somatosensory evoked potential testing (bottom)