Progressive Changes in Bladder Muscle Correlate with Injury Severity after Experimental Chronic Cervical Spinal Cord Injury

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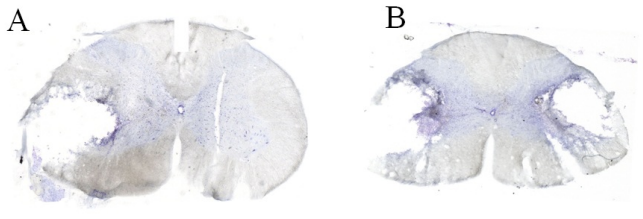
Introduction

Urologic complications remain a significant source of morbidity after SCI. Recovery of urinary function is a high priority among the SCI population for future research. While urinary dysfunction after human SCI is well-documented, preclinical studies reveal conflicting results, complicating translational research. Experimental thoracic transection injuries demonstrate pathologic changes in bladder compliance, weight and elastin content. More clinically relevant experimental contusion injuries show paradoxical normal recovery of urinary function. Investigating potential therapies relies on translational models that parallel the clinical condition. Therefore, we sought to demonstrate urinary dysfunction post-SCI by assessing for pathologic changes in bladder muscle in a clinically relevant model of cervical contusion.

Methods

Using a rodent mid-cervical(C4-5) contusion model, we assessed three groups: uninjured(n=22), unilateral contusion (moderate SCI) (n=51), and bilateral contusion (severe SCI) (n=34). Bladders were harvested at 7, 14, 28 or 56 days post-injury, assessing for bladder weight and elastin concentration.

Figure 1

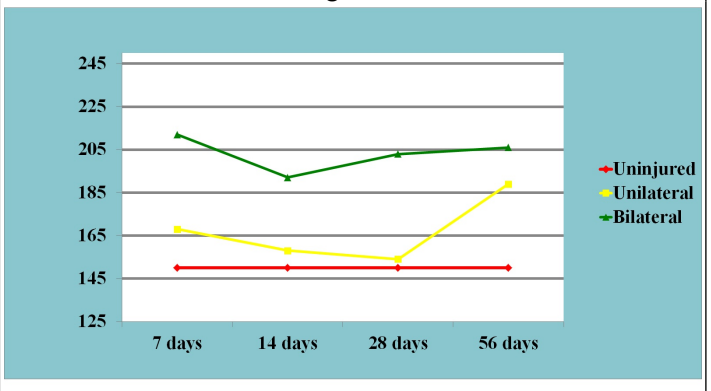


Histologic sections demonstrating: A) Unilateral (moderate) contusion, B) Bilateral (severe) contusion

Results

Uninjured mean bladder weight was 150 mg. Mild SCI mean bladder weight was increased at 168, 158, 154, 189 mg at 7, 14, 28, 56 days post-SCI. Severe SCI mean bladder weight was 212, 192, 203, 206 mg, at same time points (**Figure 2, Table 1**). Elastin concentration also correlated with severity of SCI. Mean uninjured elastin concentration was 0.277 mg/g. Mild SCI mean elastin concentration increased from 0.262, 0.276, 0.289, to 0.330 mg/g tissue, at 7, 14, 28, 56 days post-SCI. Severe SCI mean elastin concentration had a greater increase from 0.318, 0.302, 0.297 and 0.344 mg/g tissue, at same time points (**Figure 3, Table 2**).

Figure 2

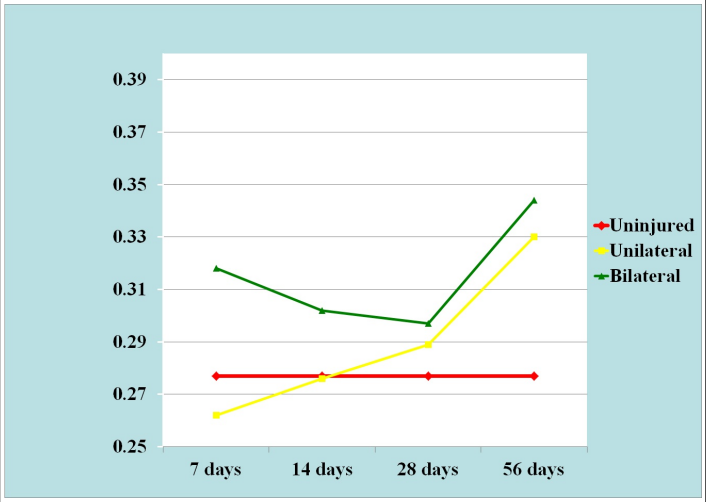


Graph demonstrating mean bladder weights for: uninjured, unilateral contusion, bilateral contusion animals

Table 1

Days Post Spinal Cord Injury	Uninjured Bladder Weight (mg)	Unilateral Bladder Weight (mg)	Bilateral Bladder Weight (mg)
7 Days	150	168*	212*
14 Days	150	158	192*
28 Days	150	154	203*
56 Days	150	189*	206*

Figure 3



Graph demonstrating mean elastin concentratino for: uninjured, unilateral contusion, bilateral contusion animals

Table 2

Days Post Spinal Cord Injury	Uninjured Elastin Concentration (mg/g tissue)	Unilateral Elastin Concentration (mg/g tissue)	Bilateral Elastin Concentration (mg/g tissue)
7 Days	.277	.262	.318*
14 Days	.277	.276	.302
28 Days	.277	.289	.297
56 Days	.277	.330*	.344*

Conclusions

Significant increases in bladder weight and elastin concentration were observed after experimental SCI, representing pathologic changes in bladder muscle as a result of injury. Changes correlated with injury severity, with evidence of chronic deterioration. This may serve as a valuable model for assessing neural repair strategies for recovering urinary function after chronic SCI.