

Injury severity and timing of decompression after spinal cord injury – a review of preclinical studies

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# Introduction

Sustained compression after spinal cord injury (SCI) exacerbates tissue damage and adversly affects outcomes. Surgical decompression may ameliorate ongoing damage from sustained compression and may improve outcomes especially for mild or moderate primary injury. Most clinical studies favour early decompression however the timing for decompression continues to be debated. Several laboratory investigations on SCI-sustained compression paradigm have been performed with mixed results. The results of these studies were systematically reviewed within a framework of primry injury severity classification.

# Methods

The published laboratory investigations were reviewed for method of SCI creation, type and degree of sustained compression, timing of decompression and behavioral assessment. A primary injury severity classification was developed based on behavioral outcomes in the control groups. SCI was categorized as mild (BBB score 18-21 or Tarlov 5), moderate (BBB 9-17, Tarlov 4), and severe (BBB <9, Tarlov <4). The sustained compression was considered as mild (<30%), moderate (31-40%), and severe (>40%) based on the extent of canal compromise. The outcomes were categorized as good or poor based on mean scores greater or less than antigravity.

#### Results

10 preclinical studies of SCI-compression paradigm were reviewed.(Table 1) For mild primary injury, a sustained mild to moderate compression for 6 hours resulted in poor functional recovery. This time window appears to be smaller for severe compression (<3 hours). (Table 2) On the other hand the timing of decompression doesn't appear to affect outcomes after severe primary injury. In the moderate primary injury group good outcomes were reported after moderate compression for <12 and severe compression for <6 hours.

Reference	Species	Injury Method	Control Group	Treatment
Croft et al. (1972)	Cat (n=15)	Weight-holding apparatus	No Control	Removal of weight compression
Thienprasit et al. (1975)	Cat (n=28)	Epidural balloon: Instant expansion and immediate deflation	Decompressive laminectomy alone	Decompressive laminectomy and cooling
Dolan et al. (1980)	Rat (n=91)	Vascular clip compression	2 groups: normal and 5mm myelectomy	Decompression by clip removal
Guha et al. (1987)	Rat (n=75)	Vascular clip compression	2 groups: normal and cord transection	Decompression by clip removal
Delamarter et al. (1995)	Dog (n=30)	Nylon band constriction	Band Constriction with immediate decompression	Decompression by band removal
Carlson et al. (1997)	Dog (n=21)	Precision loading device	Group with shortest time to decompression (30 min.)	Decompression by releasing pressure device
Dimar et al. (1999) - 2 studies	Rat (n=40), (n=42)	NYU Impactor contusion with spacer-induced canal stenosis	First study, 2 groups: Spacers without contusion, contusion without spacers Second study: contusion with immediate decompression	Decompression by spacer removal
Carlson et al. (2003)	Dogs (n=16)	Precision loading device	Group with shortest time to decompression (30 min.)	Decompression by releasing pressure device
Shields et al. (2005)	Rat (n=46)	NYU Impactor contusion with spacer-induced canal stenosis	Contusion alone	Decompression by spacer removal
Rabinowitz et al. (2008)	Dog (n=18)	Nylon band constriction	Decompression alone, methylprednisolone alone	Decompression by band removal + IV methylprednisolon

TABLE 2 SUMMARY OF PRECLINICAL STUDIES FOR TIMING OF DECOMPRESSION ON GROSS LOCOMOTOR OUTCOMES (MORE THAN OR BELOW ANTIGRAVITY) IN RELATION TO INJURY SEVERITY

Sustained	Primary Injury - Mild SCI	Primary Injury –	Primary Injury -
compression		Moderate SCI	Severe SCI
Mild (≤30% decrease in diameter)	More than antigravity ≤6 hours (Guha-87, Dimar-99)	More than antigravity with immediate decompression (Thienprasit-76)	Below antigravity irrespective of timing of decompression (Thienprasit-76)
Moderate	More than antigravity <6	More than antigravity ≤12	-
(31-40% decrease	hours	hours	
in diameter)	<sup>(Dimar-99)</sup>	(Shields-05)	
Severe (>41% decrease in diameter)	More than antigravity <3 hours (Carlson-03, Delamarter-95, Dimar-99)	Below antigravity except for decompression ≤6 hours with 43% canal compromise (Guha-87, Shields 05)	Below antigravity irrespective of timing of decompression (Guha-87, Rabinowitz-08)

## Learning Objectives

Preclinical studies support early decompression especially for mild and moderate primary injury.

### Conclusions

Primary injury strongly correlates with functional outcomes in the preclinical studies of SCI. Sustained compression also affects outcomes in time dependent manner especially for mild and moderate primary injury.

#### References

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