Acute spinal cord injury increases callus formation during fracture healing in an experimental rat model

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Introduction
In patients who have sustained traumatic brain or acute spinal trauma associated with fractures of extremities, the rate of new bone formation around the fracture site is increased. Moreover, heterotopic ossification is a fairly common complication in spinal cord injury and brain trauma. The research activities of Boes et al. observed accelerated bone healing in rats with traumatic brain injury. An interaction between central nervous system and bone metabolism seems to be obvious. But limited literature data is available and the mechanism remains still unclear. Upgrading understanding of the pathomechanisms might give treatment options for heterotrophic ossifications and in addition for delayed bone union. The objective of this study was to establish a reproducible animal model in order to study the influence of acute spinal cord injury on fracture metabolism.

Methods
A mid diaphyseal femur osteotomy was created in 35 female sprague dawley rats. Therefore the right femur was exposed and a Polyeetherketon (PEEK) plate with angular stable fixation (AO Development Institute, Switzerland) was fixed. A transverse osteotomy was performed using a gigli-wire saw resulting in a 2 mm gap. The animals were randomly assigned into intact controls (14d and 28d) and spinal cord injury groups (14d and 28d). The spinal cord was injured at day of osteotomy using a balloon compression technique. Therefore a catheter is inserted into the epidural space, after laminectomy of the T10 arch, advanced cranial to the T8-9 spinal level, inflated and hold for 20 min.

For behavioural testing, open field locomotion activity is evaluated by using the BBB rating scale (Basso et al., 1995). The scale ranges from 0 to 21, where 0 reflects no locomotor activity and 21 reflects a normal performance. The BBB score gives us also the possibility to evaluate the strength of the spinal cord trauma. The time points for the testing will be 24 hours after operation and the day of the euthanasia (14d or 28d). Callus formation was analyzed as BV at 14 or 28 days after surgery using micro CT (1076, Skyscan, Belgium) and with histology (decalcification, paraffin section, HE-stain).

Results
The radiological scout view of the femurs showed increased callus formation in animals with spinal cord injury at 14 days after surgery. In contrast to control group (14d) the callus formation was not restricted.

Discussion
To our knowledge this is the first reproducible animal model to study the increased bone formation in acute spinal cord injury. The femur osteotomy was fixed with a rigid angular stable screw-plate-device that provides standardization of the bone injury and decreases the influence of body motion on the process of bone healing. Significant increased endosteal and periosteal callus formation was found at 14 days after spinal cord injury in contrast to control group (p<0.05). The decrease in callus volume after 28d might be caused by the alteration process of the callus to lamellar bone after maturation. The model seems to simulate the clinical findings in patients with spinal trauma. Factors that are responsible for the stimulation of bone formation are to be characterized using this new rat model.

References