journal of surgical research 199 (2015) 552–556

Available online at www.sciencedirect.com

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journal homepage: www.JournalofSurgicalResearch.com

Correlations between posterior longitudinal injury and parameters of vertebral body damage

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ARTICLE INFO

Article history:
Received 10 March 2014
Received in revised form
18 March 2015
Accepted 21 April 2015
Available online 28 April 2015

Keywords:
Thoracolumbar burst fractures
Posterior longitudinal ligament
Kyphosis
Canal compromise
Vertebral height

ABSTRACT

Background: The posterior longitudinal ligament (PLL) is an important structure of spinal stability. The loss of vertebral body height, local kyphosis (LK), and canal compromise may lead to spinal instability. This study determined the correlations between injury of the PLL and the loss of vertebrae height, kyphosis, and canal compromise.

Materials and methods: A retrospective review of a thoracolumbar burst fracture database was conducted from January 2009 to December 2011. Patients were divided into an intact group and a disrupted group according to the status of the PLL. The loss of vertebral height, mid-sagittal canal diameter, and LK was measured. The anterior, middle, and posterior vertebral compression ratios (AVBCR, MVBCR, and PVBCR) and mid-sagittal diameter compression ratio (MSDCR) were calculated.

Results: Forty-seven patients were included in the study, including 25 patients in the intact group and 22 patients in the disrupted group. There were significant differences in the AVBCR ($t = -3.048$, $P = 0.004$), MVBCR ($t = -2.301$, $P = 0.048$), PVBCR ($t = -2.116$, $P = 0.040$), and MSDCR ($t = -4.095$, $P = 0.000$) but no difference in the LK ($t = 0.408$, $P = 0.686$) between the two groups. There was a positive correlation between the injury of the PLL and the MSDCR ($r = 0.428$, $P < 0.01$), AVBCR ($r = 0.372$, $P < 0.01$), and PVBCR ($r = 0.271$, $P < 0.05$). There was no correlation between the injury of the PLL and the LK and MVBCR.

Conclusions: The MVBCR and LK are not predictive of a PLL injury. The MSDCR, AVBCR, and PVBCR were associated with a PLL injury.

1. Introduction

Denis defined a burst fracture as the failure of the anterior and middle columns under compression and defined instability as a middle column injury associated with either a posterior ligamentous complex (PLC) or anterior column injury [1]. Therefore, the middle column is the main structure of spinal stability. Biomechanical studies demonstrated that the posterior

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http://dx.doi.org/10.1016/j.jss.2015.04.068

longitudinal ligament (PLL), as well as the posterior aspect of the annulus, needed to be disrupted to create instability. Therefore, the PLL status is important for assessing the stability of the spine in thoracolumbar burst fractures. Before the use of routine magnetic resonance imaging (MRI) to assess the status of the PLL, radiographic criteria were used to predict the instability and treatment outcome in the setting of a thoracolumbar burst fracture [2–4], including the loss of the vertebral body height and local segmental kyphosis [2–5]. Although these thresholds are commonly referenced in textbooks and used in surgical decision making, studies have demonstrated that bony parameters are not associated with the outcome of treatment of thoracolumbar burst fractures [6–8].

PLL injury is a risk factor for spinal instability. According to a biomechanical study [9,10], with the isolated destruction of the anterior or posterior columns, one could expect a loss of 22% in the load carrying capacity; the load carrying capacity decreased by 70% with anterior and middle destruction in flexion; and with posterior and middle column destruction, the load carrying capacity decreased to 40%. Therefore, the PLL plays a significant role in resisting flexion-deforming forces in the thoracolumbar burst fractures.

Although the loss of the vertebral body height, LK, and canal compromise are often quoted parameters to implicate instability, the relationship of these parameters to PLL injury has not been demonstrated in a human clinical series. The purpose of this study was to determine the correlations between the PLL injury as seen on magnetic resonance (MR) images and the loss of vertebral body height, canal compromise, and kyphosis.

2. Materials and methods

We retrospectively reviewed consecutive patients with a thoracolumbar (T_{11}–L_2) burst fracture from a single center. Patients with a single vertebral thoracolumbar burst fracture due to trauma met the following criteria: (1) patients were examined by a multiplanar computed tomographic scan before surgery; (2) surgery was performed within 3 d; (3) the status of the PLL was clear on the MRI image; and (4) all patients underwent spinal surgery with the same posterior instrumentation (USS fracture; Depuy Synthes, Eimattstrasse, Oberdorf, Switzerland).

2.1. *Axial-plane central canal measurements*

The mid-sagittal canal diameter (MSD, Fig. 1) was defined as the distance between the posterior canal border and anterior canal border. All of the measurements were measured directly with the assistance of Mimics10.01 (Materialise Corporation, Belgium). The MSD compression ratio (MSDCR) was calculated according to the formula $[(V1 + V3)/2-V2]/(V1 + V3)/2$ [10,11]. V1 indicates the MSD at the level above the injury canal. V2 indicates the MSD of the injured canal. V3 indicates the MSD at the level below the injured canal.

2.2. *Sagittal-plane central canal measurements*

LK (Fig. 2) was defined as the angle formed between a line drawn parallel to the superior end plate of one vertebra above the fracture and a line drawn parallel to the inferior end plate of the vertebra one level below the fracture [12].

The anterior vertebral body compression ratio (AVBCR, Fig. 3), the middle vertebral body compression ratio (MVBCR, Fig. 3), and the posterior vertebral body compression ratio (PVBCR, Fig. 3) were calculated according to the formula $[(V1 + V3)/2-V2]/(V1 + V3)/2$ [10,11]. V1 indicates the height of the vertebra at the level above the injury vertebra. V2 indicates the height of the injured vertebra. V3 indicates the height of the vertebra at the level below the injured vertebra.

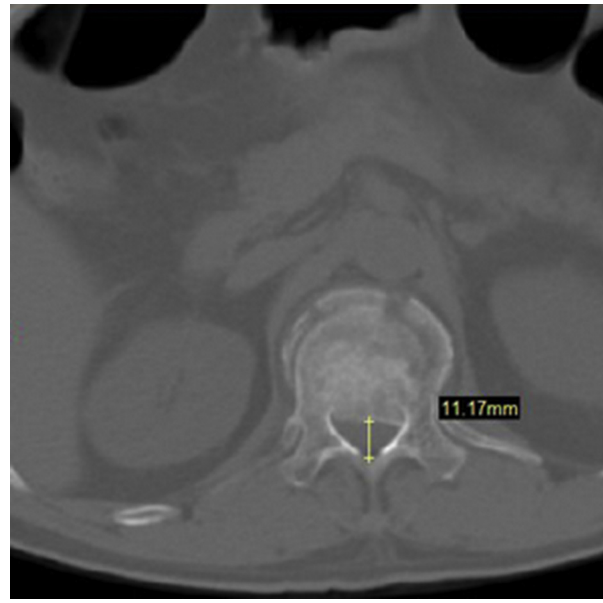

Fig. 1 – Axial computed tomographic image of a L1 burst fracture at the level of the pedicles, demonstrating technique used to measure the mid-sagittal diameter, the mid-sagittal diameter was 11.17 mm in this sample. (Color version of the figure is available online.)

Fig. 2 – Midsagittal computed tomographic image demonstrating the method used to measure vertebral body Cobb angle on a T12 burst fracture, the kyphosis was 34.68° in this example. (Color version of the figure is available online.)