Introduction: In vitro biomechanical testing of the spine is a well established method to analyze, compare and evaluate different strategies in treatment of spinal fractures [1-3].

Fracture morphology has an important influence on the clinical decision making process of its treatment. By investigating spinal fracture care in vitro, the different types of fractures leading to distinct treatment in clinical routine need to be considered. Aim of this study is to develop a method for reproducible production of different types of burst fractures in a specific vertebra, based on the widely used AO-Classification, described by Magerl et al.[4].

Materials and Methods: Fresh frozen five segmental thoracic, thoracolumbar or lumbar calf specimens were thawed for 12 hours, carefully resected from muscles, tendons and ligaments and embedded in PMMA at the caudal and cranial vertebrae. The specimen was mounted into a servohydraulic material testing machine (Instron 8874, see Fig.1 a). Predetermined breaking point in the middle vertebra was generated with a surgical chisel. Depending on the desired fracture type an anterior cut (wedge impaction fracture) or rhombical cuts (burst fractures) either into the cranial or caudal part of the vertebra reaching the adjacent disc were performed. Vertebrae above and underneath the rated break point were temporarily fused with plates and screws to concentrate the applied energy to the target vertebra. The specimen was axially compressed with the testing machine in a position controlled manner and with a speed of 300mm/s. For complete burst fracture, the machine covered a distance of 20mm. For incomplete burst and wedge impaction fractures 10mm. Maximum failure load was recorded for each specimen. CT scans were enforced to check the course of the breakage (see Fig.1 b,c).

Results: Predetermined breaking points and the compression distance applied by the testing machine are the variables that have to be altered to achieve different fractures as desired. Measured forces range between 7kN (burst fractures) and 12kN (wedge impaction fractures).

With the described model it is possible to create reproducible superior or inferior wedge impaction fractures (Magerl A 1.2.1 and A 1.2.3), superior or inferior incomplete burst fractures (Magerl A 3.1.1 and A 3.1.3) or complete axial burst fractures (Magerl A 3.3.3).

Discussion: The ideal system of fracture classification should serve as a base for accurate communication and should guide the choice of treatment [4]. This widely accepted claim on classification systems should also be paid attention to in biomechanical research on spinal fractures.

Based on the “dropping mass method” described by Cotterill et al. in 1987 [5] axial compression in 15 degree flexion creates reproducible burst fractures for different species. Nevertheless, no further determination on different types of burst fractures have been reported [3, 5, 6].

Using a servohydraulic testing machine probably results in less impact than a dropping mass. Anyway, using the distance controlled mode of a servohydraulic testing machine that is able to handle forces up to 15kN and a velocity of compaction up to 300mm/s will increase the control and diversity in creating different fracture patterns based on a clinical used comprehensive classification.

Predetermined breaking points described in this study may help to create reproducible fracture types as desired.

Fracturing a vertebra is only a part of spinal biomechanical investigation. Dynamical testing of the spine and evaluation of Neutral Zone, Range of Motion etc. is the major method to evaluate spinal behaviour before and after treatment. The described fracture method can be seen as one component of a spinal testing operation. Ideally, the intact specimen would be tested dynamically e.g. with the help of a sensor guided robot, than the fracture is being produced. Another dynamical test might be performed and finally, the specimen could be treated and once more dynamically tested.

Calf spines are commonly accepted for biomechanical spinal testing, however important differences to human spines have been shown.

Further studies have to be performed to investigate the effect and reproducibility of the presented method in creating specific fracture patterns in other species, especially in humans. Hereby the distance controlled compression could possibly lead to a reproducible distinct fracture even in osteoporotic bone.


Acknowledgements: The authors are indebted to Josef Boes, Martin Wensing and Axel Zscheile from the machine shop (precision mechanics) of the University Hospital Muenster for producing all necessary tools.

Fracturing a vertebra is only a part of spinal biomechanical investigation. Dynamical testing of the spine and evaluation of Neutral Zone, Range of Motion etc. is the major method to evaluate spinal behaviour before and after treatment. The described fracture method can be seen as one component of a spinal testing operation. Ideally, the intact specimen would be tested dynamically e.g. with the help of a sensor guided robot, than the fracture is being produced. Another dynamical test might be performed and finally, the specimen could be treated and once more dynamically tested.

Calf spines are commonly accepted for biomechanical spinal testing, however important differences to human spines have been shown.

Further studies have to be performed to investigate the effect and reproducibility of the presented method in creating specific fracture patterns in other species, especially in humans. Hereby the distance controlled compression could possibly lead to a reproducible distinct fracture even in osteoporotic bone.


Acknowledgements: The authors are indebted to Josef Boes, Martin Wensing and Axel Zscheile from the machine shop (precision mechanics) of the University Hospital Muenster for producing all necessary tools.

Fracturing a vertebra is only a part of spinal biomechanical investigation. Dynamical testing of the spine and evaluation of Neutral Zone, Range of Motion etc. is the major method to evaluate spinal behaviour before and after treatment. The described fracture method can be seen as one component of a spinal testing operation. Ideally, the intact specimen would be tested dynamically e.g. with the help of a sensor guided robot, than the fracture is being produced. Another dynamical test might be performed and finally, the specimen could be treated and once more dynamically tested.

Calf spines are commonly accepted for biomechanical spinal testing, however important differences to human spines have been shown.

Further studies have to be performed to investigate the effect and reproducibility of the presented method in creating specific fracture patterns in other species, especially in humans. Hereby the distance controlled compression could possibly lead to a reproducible distinct fracture even in osteoporotic bone.


Acknowledgements: The authors are indebted to Josef Boes, Martin Wensing and Axel Zscheile from the machine shop (precision mechanics) of the University Hospital Muenster for producing all necessary tools.