A surgery simulation of fractured vertebral body relocation on segment of animal spine

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1. Introduction

Surgical relocation of damaged fragments of vertebral body is an effective method of treatment for spine thoracic-lumbar region's compressive fracture. The effect of this relocation is forced change in distance between neighbouring surfaces of vertebral bodies connected with fibrous ring of intervertebral disc as well as ligaments and skeletal muscles system. Researches show [1, 2] that ligament structures and fibrous rings are main participants in the procedure of surgical relocation of vertebra and the greatest role is given to longitudinal ligaments. Therefore there is a great need to assess the value of displacement and force during the procedure of broken vertebra relocation. In the first step an experiment on animal spine i.e. segment of swine lumbar spine consisting of 5 vertebrae (L2-L6) was conducted. The surgical Synthes equipment was applied.

2. Methods

Standard surgical technique of fracture relocation with fractured posterior wall as described in the instruments and implants producer's manual was used in the experiment [3].

A special working stand has been prepared. It consisted of inflexible base and elements stabilising the fragment of swine spine. During the research a 13-element implant system for skeletal spine stabilisation (USS Fracture – Universal Spine System) was used as well as special surgical instruments.

3. Results

The procedure of vertebra relocation was performed during a surgery on swine spine segment by surgeons of Military Medical Institute. Preliminary measurements possible to make at the working station has been defined during the surgery: preoperative, intraoperative and postoperative. The surgery on the animal spine has been performed according to standard surgical technique used in similar clinical cases of human spine thoracic-lumbar region's compressive fracture. In the first stage of the surgery on the specimen, approach to articular processes and discs was provided by removing part of muscular tissue. In order to uncover the entrance to the neural arch pedicle, partial resection of articular process had to be performed. In the next stage, holes for Schanz screws were made and installed together with pair of rods and fracture clamps for rods. After performing a simultaneous distraction along the spine axis (angle 10°) using two distractors clamped at the same time and set symmetrically (fig. 1), clamps were tightened. After taking the distractors off, the Schanz screws were moved toward the centre along the spine axis with simultaneous twist according to surgical technique. To recreate the posterior wall of vertebral body it is necessary to perform pressing and crossing of screws at the same time. At the end, the rod structure has been transformed into frame one by connecting two hard rods with a rod for cross-link stabilizer and tightening the clamps (fig. 2) The condition of the skeletal system after conducting the experiment has been examined after removing soft tissue from the specimen. It turned out that anterior wall of vertebral body has been pierced by three of the four Schanz screws. During a real surgery, intraoperative X-rays or CT previews are done.
4. Discussion

Forcing a change in distance between neighbouring surfaces of vertebral bodies and damaged vertebra with transpedicular screws requires applying quite a lot of force by the surgeon while performing the surgical procedure which is the result of used instruments. At present time according to available literature and knowledge, value and direction of applied force are not monitored during surgery with suitable measurements. The performed experiment revealed that there is a need to measure force while distracting vertebra and installing screws because of the possibility that vertebral body anterior wall may get pierced. Further research should yield the value of the force which ought to be applied to recreate vertebral body posterior wall completely. Conducting such measurements on an animal specimen will let us develop and execute proper instruments equipped with measuring sensors, which can be used in human spine surgeries. Scientific literature describes a way of measuring real displacement of spine extension with extensometers. Further studies predict using the method to evaluate the force necessary to recreate vertebral body posterior wall completely.

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References