6. Controlling forces in trauma indications: How to get the best of the technique

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Background

The principle of fracture treatment is simple: reposition, stabilization and maintenance of stabilization. The challenge of spine surgery in 2022 is the management of poor bone quality in osteoporosis. In Germany, 80% of all vertebral fractures are due to poor bone quality.

Challenges of Reduction and Stabilization

In general, fracture reduction should always be attempted by hyperlordotic positioning of the patient using ligamentotaxis. For this purpose, the patient's legs are pulled until adequate spinal distraction is achieved. In spine surgery, there are a variety of strong and powerful instruments designed for reduction, such as persuaders, rockers or pushers. The use of these devices reduces pedicle screw anchorage in bone by nearly 50%, with little difference between normal and osteoporotic bone. A 5mm reduction is enough to cause screw loosening[1]. Especially in elderly patients with traumatic indications, the use of these instruments should be avoided.

Loosening or pulling out of the pedicle screw is a relevant complication that occurs in about 15% of cases in good bone quality. 82% of the loosened screws were pulled out during the final rod connection[2]. The risk of screw loosening can be reduced by 48% by achieving an optimal fit of the rod/screw interface[3].

Forced Fixation – A Problem of design?

Conventional spinal instruments are heavy (0.8 kg to 1.5 kg), have long lever arms and a center of gravity far away from the surgical site. This reduces tactile feel and increases the load on the implants by a factor of 40. These instruments block the polyaxiality of the screw head and thus prevent a perpendicular alignment of rod and screw. Forceful reduction maneuvers pull the spine toward the rod, creating high loads, and flat set screws prevent orthogonal alignment of the rod and screw during the last half turn, promoting cold welding and stabilization failure.

Controlled Fixation in Trauma Indications

The three main principles of controlled fixation are:

1. To place the screw head in a reproducible anatomical position,
2. To keep the screw head polyaxial, and
3. Control the mechanical forces.

This is supported by the use of balanced, lightweight instruments with short lever arms that provide tactile feedback and visual control of screw position, reduction and fit of the rod to the screw. Rod reduction through polyaxiality of the screw heads allows stress-free and controlled positioning of the rod. The convex screw design and the "frictionless" locking mechanism support controlled final tightening, reducing cold welding and implant failure. Locking the construct should always be parallel, symmetric, and alternating to control coronal deformity, sagittal compression or distraction, and mal-rotation.
Another key to stable screw fixation in the osteoporotic spine is cement augmentation in conjunction with a maximum screw diameter[4]. Using 1ml bone cement per screw increases the fatigue load by 41%[5]. In addition, intermediate screws at the fracture level have been shown to significantly improve maintenance of correction[6].

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