Traumatic spinal fractures the fall and rise

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GENERAL INTRODUCTION

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The critical role of the spine in the human body is emphasized by the taxonomic classification Vertebrata. This encompasses species of animals that represent the majority of the (phylum) Chordata, which indicates animals with a chorda, or, spinal cord. In vertebrates, the spinal cord is protected by a bony spine which consists of several vertebrae, directly indicating the large consequences a vertebral fracture may have. Most of the time however, the spinal cord remains intact while the bony part is injured. Apart from protecting the spinal cord, the bony spine forms an important part of the human supportive skeletal system.

Traumatic spinal fractures are a relative frequently occurring problem, whether it is in young patients due to high energy trauma or elderly that slip while in their own residence. While polytraumatized often suffer a spinal fracture (among other injuries)[1], the share of elderly with a spinal fracture is reported to be large in other western countries[2, 3]. Depending on the injury and the patient, these fractures can be treated operatively or conservatively. Whether it is a young active patient or an older patient already requiring help, these injuries might have serious consequences for patients and their environment. Furthermore, absence of work due to spinal fractures [4-6] has its socioeconomic effects on society.

Studies that report the incidence of spinal fractures in other countries[2, 3, 7-9] give us an idea of the magnitude of this problem, however the incidence in the Netherlands is currently unknown. Furthermore, details such as patient characteristics, trauma mechanisms and associated injury are important to act on preventative measures. Therefore, **Chapter 1 describes the current incidence in the Netherlands and it's fluctuation over the last ten years using the largest available national data collection.** Additionally, patient and injury characteristics are reported. **Chapter 2 focuses on characteristics of these injuries in more detail as presented to a regional level 1 trauma center.**

Operative treatment

The earliest treatment of spinal fractures consisted of non-operative treatments, such as applying traction and hyperlordosis using a traction table designed by Hippocrates. This was followed by the use of plaster casts(10) and physiotherapy. Currently, there is a large range of surgical techniques to treat specific types of spine fractures. The pedicle screw is one of the surgical instruments that has had the largest influence on spine fracture treatment in the last decades. Although for specific types of fractures (such as osteoporotic) still sometimes debated, pedicle screws are an effective treatment for most spine fractures. In addition to reinforcing the posterior spinal column with pedicle screws, some fracture types need

additional anterior column reinforcement due to an insufficient load bearing capacity(11). However debate still exists whether anterior fixation with a titanium cage is of additional value compared to solely posterior fixation. Therefore **in chapter 3 a systematic review and meta-analysis is described comparing combined posterior- and anterior fixation with a titanium cage versus solely posterior fixation.**

There are several ways to reinforce the anterior column. One of these is the transpedicular approach, such as kyphoplasty and vertebroplasty, these were first introduced mainly for osteoporotic fractures to reinforce the anterior column with bone cement. Although complications such as cement leakage and adjacent vertebra fracture were reported[12, 13], combined with the questionable effect on symptoms and long term outcomes[14] caused a decrease in the use of these techniques. Another method is the trans-thoracic direct anterior approach, this way a (partial) corpectomy can be performed and the anterior column is supported with a bone graft or titanium cage. The first direct access to the anterior column was by thoracotomy and thoracophrenicolaparotomy, however with high approach related morbidity[15]. Therefore, minimally invasive thoracoscopy was introduced, although this was actually an improvement of an old technique. The first documented thoracoscopy dates already from 1865[16] and was performed by a urologist, who used a cystoscope to examine the pleural cavity through a pleurocutaneous fistula. It was only relative recently in the 1990's that the second evolution started by development of small camera's that allowed video assisted thoracoscopy (VATS), first mainly used for lung surgery. While these cameras were first used in addition to a mini-thoracotomy, now a full thoracoscopic approach exists[17-19]. However, the long term outcomes of this approach are currently unknown. Therefore, **chapter 4 describes the quality of life and long-term results after thoracoscopic treatment with a titanium cage.** Whereas most studies evaluate a technique by radiologic outcomes, we have focused mainly on patient reported outcomes. In the meantime, 3D-thoracoscopy was introduced, first in laparoscopic and thoracic surgery[20, 21]. In lung- and abdominal surgery, improved surgical performance and decreased operative times have been reported using this technique[22, 23]. While the technique itself has a slight learning curve for surgeons, it may provide shorter learning curves for surgeons in training due to improved spatial orientation. **Chapter 5 describes how this technique is first applied for spine fractures and additionally reports the first results and experiences.**

Post-operative treatment

While operative treatments evolve fast, in post-operative treatment questions also remain. Several years ago, nearly all patients were treated with a post-operative orthosis. Recent studies report no additional value of an orthosis in conservative treatment of spinal fractures[24]. Even after treatment of osteoporotic fractures the value of an orthosis is being questioned[25]. After

operative fixation, the pedicle screw construct is assumed to provide intrinsic stability and therefore an additional orthosis is used based on surgeons' preference[26]. While the effect on fracture healing and radiologic results might be negligible, patients could experience advantages. An orthosis provides additional stability and could provide pain relief and trust in rehabilitation. The downside of an orthosis is that it could be a considerable burden and cause muscle weakening, especially if it has to be worn for longer periods of time. As evidence of a post-operative orthosis is currently lacking, **chapter 6 describes the protocol of a currently running randomized controlled trial that differentiates between a post-operative orthosis and no orthosis (ORNOT-trial).**

When the fracture has consolidated and patients have maximally recovered, usually between 6 to 12 months post-operatively, the question arises whether the posterior implants should be removed or left in situ. Some patients have implant related symptoms which could be resolved, although removing the material is a surgical procedure and poses additional risks. **Chapter 7 describes the long term results in patients that underwent implant removal after posterior fixation.**

Posttraumatic kyphosis

Although treatment options are numerous nowadays, it remains difficult to appoint the perfect treatment to each individual patient, usually largely based on radiologic examinations. Consequently, it is inevitable that some patients will be subject to vertebral body collapse and increasing kyphosis after initial treatment. Progressive kyphosis is often accompanied by pain and has considerable influence on quality of life and back-related function[27]. The severe kyphosis may be reason for surgical treatment. One option is posterior shortening through a pedicle subtraction osteotomy, a complex procedure with risks of neurological injury. Another option however, is anterior lengthening which might be done using a solely anterior approach or a combined anterior and posterior approach. **In chapter 8, the results of anterior treatment of posttraumatic kyphosis through a minimally invasive thoracoscopic approach are described.**

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