Spinal aging

VALORIZATION

Spinal disorders are common and have a substantial impact on both patients and society, affecting more than 1.7 billion people worldwide. With aging of our population the burden of spinal disorders on society, in terms of quality of life and costs, is expected to increase further. For instance, the risk of fractures after falling in people with osteoporosis is high due to increased bone fragility. These fragility fractures are associated with significant mortality, morbidity, and low quality of life. The economic burden of incident and prior fragility fractures is huge (approximately 37 billion euros in 2010 for Europe) and the costs are expected to increase by 25% in 2025.

New osteoporotic vertebral compression fractures (OVCFs) occur in approximately 500,000 patients per year in Europe. In this thesis it was shown that after an OVCF patients do not recover to their previous level of mobility. This is of high clinical importance, since impairments in balance and gait are the primary cause of recurrent falls. Early diagnosis of balance disorders after an OVCF is warranted to prevent osteoporotic patients from falling and the development of novel fragility fractures. Moreover, it was shown that dynamic bracing may prevent or slowdown the decline in postural control and the subsequent progression of hyperkyphosis with resultant global sagittal malalignment and imbalance. Prevention of falls by means of gait training or dynamic bracing could thus lead to improved patient outcomes with less chance of developing new (fragility) fractures and a subsequent hyperkyphotic deformity. Currently we are working on a novel multicenter, randomized controlled trial for the conservative treatment of OVCFs.

For OVCFs that are not responsive to conservative treatment, percutaneous vertebroplasty can be considered. In this thesis a novel cement based on gold-containing polymethamethylacrylate (PMMA) microspheres was studied. While retaining mechanical characteristics, this novel cement may provoke less inflammatory reactions as compared to the commercially available bone cements. Adjacent level complications could potentially be prevented by adjustment of the mechanical properties of PMMA cement. As the stiffness of the cement can be modified, further study is needed to examine its optimal composition and potential utility in clinical practice.

The prevalence of adult spinal deformity is increasing rapidly due to aging, demographic shifts, increased life expectancy and an increased recognition of the disorder. Adult spinal deformity has a significant and measurable impact on health-related quality of life: The International Quality of Life Assessment Project surveyed almost 25,000 people from eight industrialized nations. Compared with other chronic age-related medical conditions (including arthritis, diabetes, pulmonary disease, and heart disease), patients with spinal deformity reported significantly worse scores for pain, functional status, mental health, and social functioning. Patients with sagittal imbalance reported especially severe disability. The spinal community is challenged to manage this increasing number of spinal disorders specifically related to the elderly. Both conservative and

operative treatment can be complex in these often fragile patients because of physical deconditioning, medical comorbidities, balance and gait problems with subsequent risk of falling, and poor bone quality with concomitant risk of poor operative fixation and new fractures.

Adult spinal deformity surgery therefore is associated with high mechanical failure rates and proximal junctional failure (8-42%), for which the mechanical stiffness mismatch between rigid spinal instrumentation and low bone mineral density because of osteoporosis, is an important determinant. In this thesis, a less rigid posterior based instrumentation system by means of polycarbonate-urethane rods, has been introduced which allows for a more physiological load distribution to the adjacent segments. This system could be used for topping-off as the semirigid zone provides a gradual transition from the rigid to mobile segments to lower the stress concentration at transitional levels. The aim of this method is to decrease the incidence of adjacent segment failure. Future studies are required to test the feasibility of polycarbonate-urethane rods for this specific indication.

In addition to the significant impact on health and functional status, adult spinal deformity results in a sizeable use of resources, of which surgery is the most important determinant of outcome, risk of complications and associated costs. Despite the importance and prevalence of adult spinal deformity, variability exists in the provision of surgical or nonsurgical treatment. This high variability in management is a reflection of the lack of an evidence-based approach to care. The appropriateness criteria were developed to guide clinical decision for specific subpopulations of patients, and to limit over- and underuse of surgery. Overuse occurs when patients undergo unnecessary procedures. Conversely, underuse occurs when patients are not offered appropriate care, such as if nonsurgical specialists do not appreciate that a patient with degenerative lumbar scoliosis and sagittal plane imbalance could achieve substantial improvements with surgery. To this end, the prevention of over- and underuse of surgery will have a substantial impact on both patients and society. In this thesis it was shown that the implementation of Patient Reported Outcome Measures into the appropriateness criteria for degenerative lumbar scoliosis surgery allows for an even more patient-centered, quantifiable, transparent and uniform clinical decision-making process.

When operative treatment is indicated, it is important to obtain the best result possible by tailoring operation to the individual patient. For this purpose, we have shown that the Global Alignment and Proportion (GAP) score provides an excellent patient-specific guide for operative correction of spinopelvic alignment, and we suggest that the score will be incorporated in clinical practice for operative planning to improve both the quality and cost effectiveness of care.

In conclusion, spinal aging will demand more and more complex and intensive treatment due to the confluence of an aging population and an increased capacity and willingness to manage difficult problems in older patients. In the current thesis both

clinical and preclinical aspects of spinal aging were studied. In anticipation of aging of the population, one of the purposes of this thesis was to emphasize the significant and growing burden of spinal disorders in the elderly; to optimize current conservative and operative treatment for spinal aging; and to demonstrate that allocation of resources to the management of spinal disorders should be a priority for our healthcare economy.