Current Aspects of Fragility Fracture Repair
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Abstract
Due to the demographic developments worldwide, fragility fractures represent an increasing problem for the public health system. The risk of developing osteoporosis increases with age and is relatively higher in women and in the Caucasian population. The stability of bone is reduced because of accentuation of the normal loss of bone mass in ageing, leading to an increased susceptibility to fracture with an increased rate of complications after surgical stabilization. Due to this, the orthopedic surgeon has to assess the quality of the bone during preoperative planning and select the implants and postoperative care accordingly to achieve the best. Over the last 10 years fixed locking implants have been introduced into clinical practice. These represent a new type of angle stable fixation devices that address the mechanical instability between bone and implant. The novel problems associated with this device are due to higher cut-out rates when the bone structure is altered and mass is reduced. The developments in joint replacement have also resulted in longer standing times and lower complication rates with immediate fullweight-bearing after implantation. However, to date, little is known about the mechanisms of fracture healing in osteoporosis or fragility fractures. One future approach may be in supporting biological fracture healing by regenerative therapies using growth hormones and/or (stem) cells. The most frequent initial clinical symptom of osteoporosis is a fracture without a relevant trauma. At this stage, the trauma surgeon should initiate diagnostic procedures, treatment of osteoporosis and tertiary prevention according to the European guidelines. Ultimately, all female patients older than 50 years and all male patients older than 60 years with fractures should be assessed and treated for bone quality. Orthogeriatric specialists or interdisciplinary orthogeriatric teams should initiate a specific surgical treatment followed by early rehabilitation in order to allow the elderly patient to return to daily living as soon as possible.

Key Words
Fixed angle implants · Fracture fixation · Fragility fracture · Orthogeriatric · Osteoporosis

Osteoporosis: Short Overview
Osteoporosis is a systemic disease characterized by fragility of the bone. The first symptom of osteoporosis is often the so-called common fragility fracture. Fragility results from the loss of bone density caused by mass reduction of the trabecular structure. The most common primary form of osteoporosis easily differentiates towards secondary forms with underlying diseases. Primary osteoporosis is a multifactorial illness including genetic alterations, hormonal changes and a sedentary lifestyle [1]. Laboratory tests have as yet been unable to define individual risks for primary osteoporosis, consequently, diagnosis is based on the exclusion of known causes of secondary osteoporosis and documentation of reduced bone density by dual-energy X-ray absorptiometry (DXA). Postmenopausal osteoporosis, the most common primary form of osteoporosis, is often observed in trauma units dealing with fracture treatment. Secondary forms are predominantly medication/drug-induced forms, such as glucocorticoid-induced osteoporosis. Other known secondary forms are hormone deficiencies due to breast or prostatic cancer therapy or osteoporosis due to anti-retroviral treatment of acquired immune deficiency syndrome/human immunodeficiency virus (AIDS/HIV) [2, 3]. Therefore, the first clinical symp-

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toms of osteoporosis are frequently typical fractures, such as spine, hip, proximal humeral or wrist fractures, caused by a low-velocity fall or blow.

Osteoporosis is a widespread disease worldwide. In Germany, nearly 8 million people, representing 10% of the population, are affected, and each year about 300,000 fractures occur in osteoporosis patients. Nearly every second woman and every fifth man over the age of 50 years will sustain a fragility fracture during his/her remaining life span due to osteoporosis [4, 5]. As a result of demographic developments in industrialized countries in which the aging population is steadily increasing, osteoporosis represents a cumulative, increasing public health care problem. The relative risk of a fragility fracture increases greatly with age. In Western Europe, 12–17% of the population is currently older than 65 years. In 2050, the proportion of over 65-year-olds will reach 30%. In the future, the incidence of fragility fractures will be the leading cause of hospitalization and immobilization and, ultimately, result in increasing mortality, i.e., nearly every fifth patient suffering from a hip fracture will die within 1 year [6, 7].

This development will cause nation-wide problems in terms of enormous costs for health insurance and public health. In Germany alone, the costs associated with osteoporosis in 2003 amounted to 5.4 billion euro, representing 3.5% of the costs expended with the framework of the health insurance system [4]. The ongoing costs in Europe are 31 billion euros per year and have been estimated to rise up to 76 billion euros in 2050 [8].

Guidelines for Diagnostic and Treatment of Osteoporosis
The fracture itself often reveals the first manifestation of osteoporosis; therefore, the orthopaedic or trauma surgeon needs to know and initiate diagnostic and treatment options. In Germany, the DVO (Society of Osteologic Experts), an interdisciplinary association, developed clear structure- and evidence-based guidelines for the diagnostic and treatment of postmenopausal osteoporosis [9] according to the International Osteoporosis Foundation (IOF) European guideline [10, 11]. As such, the basis diagnostic procedure includes a history of risk factors, physical examination, routine laboratory tests, X-ray examination of the lumbar spine and DXA as the standard of bone density measurement. The DXA is reflected in the T value, which represents the standard deviation of a normal collective of young women and determines the severity of bone loss. Risk factors for the degree of bone density loss, as well as age and family history, are the main reasons to start drug treatment. According to guidelines, calcium and vitamin D substitution is combined with specific anti-resorptive treatment. For the latter, bisphosphonates are mostly used. Further treatment options include osteo-anabolic drugs, such as parathyroid hormone applied subcutaneously. Physical exercise, with and without guidance from physiotherapists, and an analysis of falls are recommended [10, 11].

In Germany, only 10% of all patients suffering from osteoporosis are treated correctly, i.e., according to evidence-based guidelines, with bisphosphonates [4]. As such, Germany is the bottom of the pile within Europe in terms of treating osteoporosis. This poor performance also stresses the need of orthopedic or trauma surgeons dealing with fracture treatment to initiate adequate diagnostic and treatment of osteoporosis.

New drugs that have to be applied only once a year intravenously have been shown to result in a significant fracture reduction rate and will hopefully lead to better acceptance and compliance in the future. The initiation of osteoporosis treatment with a yearly infusion is reasonable in a trauma unit or rehabilitation institute, but treatment costs are not incorporated in the G-DRG system (German diagnosis-related groups). In addition, a yearly infusion is only recommended 3 weeks – at the very earliest – after a fracture has been sustained or after an operation in order to avoid the accumulation of anti-absorbable drugs in the fracture region. Thus, given the current philosophy that the shorter the stay in an acute setting the better, the problem of administering the ideal drug at the ideal point of time has been shifted to rehabilitation institutes or onto the general practitioner and nursing home staff.

Do Fragility Fractures Heal Differently?
Does osteoporotic bone heal differently or slower than normal bone? This represents an important question for orthopaedic and trauma surgeons worldwide. Because of the lack of data a definitive, evidence-based answer is not yet possible [9]. Fracture healing is a complex process, dependent on many different factors. Biological repair, which depends on local stem cell and cell migration, and mechanical circumstances in the fracture fragments, are both of vital importance. Good overviews of fracture healing in osteoporotic bone are provided by Goldhahn et al., Novicoff et al., and Jacob et al. [12–14].

Although small animal tests with glucocorticoid- and hormone-induced osteoporosis after ovariectomy

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