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Review article

Surgical treatment of severe osteoporosis including new concept of advanced severe osteoporosis

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ABSTRACT

Severe osteoporosis is classified as those with a bone mineral density (BMD) T-score of −2.5 or lower, and demonstrate one or more of osteoporotic, low-trauma, fragility fractures. According to the general principle of surgical approach, patients with severe osteoporosis require not only more thorough pre- and postoperative treatment plans, but improvements in surgical fixtures and techniques such as the concept of a locking plate to prevent bone deformity and maximizing the blood flow to the fracture site by using a minimally invasive plate osteosynthesis. Arthroplasty is often performed in cases of displaced femoral neck fracture. Otherwise internal fixation for the goal of bone union is the generally accepted option for intertrochanteric, subtrochanteric, and femoral shaft fractures. Most of osteoporotic spine fracture is stable compression fracture, but vertebroplasty or kyphoplasty may be performed some selective patients. If neurological paralysis, severe spinal instability, or kyphotic deformity occurs, open decompression or fusion surgery may be considered. In order to overcome shortcomings of the World Health Organization definition of osteoporosis, we proposed a concept of 'advanced severe osteoporosis,' which is defined by the presence of proximal femur fragility fracture or two or more fragility fractures in addition to BMD T-score of −2.5 or less. In conclusion, we need more meticulous approach for surgical treatment of severe osteoporosis who had fragility fracture. In cases of advanced severe osteoporosis, we recommend more aggressive managements using parathyroid hormone and receptor activator of nuclear factor kappa-B ligand monoclonal antibody.

1. Introduction

As per the diagnostic criteria given by the World Health Organization (WHO), as well as most domestic and international guidelines, patients with severe osteoporosis are classified as those with a bone mineral density (BMD) T-score of −2.5 or lower, and demonstrate one or more of osteoporotic, low-trauma, fragility fractures [1,2]. The T-score guideline of −2.5 was established based on prevalence of osteoporosis and BMD obtained from the spine, femur, and wrist, when the WHO presented the diagnostic criteria for osteoporosis in 1994 [2]. In other words, a T-score of −2.5 in the femoral neck represents a 16% probability of a femur fracture occurring during one's lifetime, as well as a 30% probability of a fracture occurring in either the spine, femur, or wrist [2]. However, the context of classifying osteoporosis using this criterion, severe or established osteoporosis is interpreted as diagnosis based on the general concept of a fragility fracture—a phenomenon that is a common result of pre-existing osteoporosis—in addition to using the −2.5 T-score as a cutoff value. Osteoporosis related fractures can cause significant morbidity and disability, reducing the quality of life, and can even lead to death in severe cases. If hip fracture occurs, 20%–30% of patients die within 1 year [3,4]. Furthermore, 40% of patients are unable to walk independently, and 60% have difficulty with at least one essential activity of daily living 1 year after hip fracture [4]. The presence of fragility fractures has a clinically significant implication for subsequent fractures. Patients with a vertebral fracture are at about 3–5 fold higher risk for another vertebral fracture within the following year than those without

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fracture [5,6]. According to former review article for medical treatment of severe osteoporosis, Choi et al. [7] recommend selective estrogen receptor modulators (SERMs), bisphosphonates, receptor activator of nuclear factor kappa-B ligand (RANKL) monoclonal antibody, and parathyroid hormone (PTH) for the medical treatment of severe osteoporosis, based on the clinical trials and *post hoc* analyses.

In this topic review, we are going to figure out the general principle and current trend for surgical treatment of severe osteoporosis including postoperative management. We also discuss the limitations of the current WHO definition of severe osteoporosis and proposed a concept of 'advanced severe osteoporosis' to provide a more accurate assessment of the disease and allow more proactive managements.

2. Surgical treatment of severe osteoporosis

2.1. General principle

Cases of osteoporosis accompanied by fracture often require surgical treatments, and the challenges facing such surgical treatments include difficulties in achieving firm and stable fixation. In particular, many cases now require more aggressive forms of surgery due to fractures occurring in elderly patients with a clearly diminished ability to regenerate bone and fracture or refracture in patients with weak bone strength due to reduced BMD and bone quality. However,resurgery for osteoporotic fracture is often required due to malunion or nonunion from failed fixation caused by implant loosening or cut outs when attempting fixation using a metal plate and screws on thinned bone cortex and hollow bony trabecula. Therefore, the surgical approach for patients with severe osteoporosis requires not only more thorough pre- and postoperative treatment plans, but improvements in surgical fixtures and techniques as well. Consequently, efforts should be made to achieve successful surgical outcomes through various novel approaches, including, the use of different techniques, such as treatments using the concept of a locking plate to prevent bone deformity due to screw loosening and maximizing the blood flow to the fracture site by using a minimally invasive plate osteosynthesis (MIPO) [8] (Fig. 1).

The major fracture sites of osteoporosis are spine, hip, proximal humerus, and distal radius. When describing the surgical principle, the fracture of the vertebrae and the around joint are completely different. The general principle of joint around fracture is very similar compared to vertebral fracture. In this review, the vertebral and hip fractures are described as the most common and serious osteoporotic fracture.

2.2. Hip fracture

Osteoporotic hip fractures among the elderly often involve existing medical diseases, and these cases also face a high risk of medical complications during the surgical treatment process. Therefore, in cases where surgical treatment is unavoidable, thorough pre- and postoperative precautions against medical issues are required. The general principle and goal of surgical treatment is to allow the patient to recover as much independent function as possible by achieving firm internal fixation in the early stages, or to perform arthroplasty according to the fracture pattern, whereby early movement and gait could be enabled along with rehabilitation therapy. Through such processes, postoperative medical complications can be minimized as well. Osteoporotic proximal hip fractures can be classified as femur neck, intertrochanteric, and subtrochanteric fractures based on the anatomical location of the fracture, while distal fractures include the femoral shaft and diaphyseal fracture (Fig. 2A). Arthroplasty is often performed in cases of displaced femoral neck fracture and minimally displaced femoral neck fracture with high risk of internal fixation failure due to severe osteoporosis (Fig. 2B). Although some surgeons may choose arthroplasty as a surgical treatment for intertrochanteric fractures, internal fixation for the goal of bone union is the generally accepted option for intertrochanteric, subtrochanteric, and femoral shaft fractures. The biggest problem associated with internal fixation on osteoporotic hip fracture is that firm internal fixation is difficult to achieve due to reduced bone quality and strength, which also increases the risk of fracture reduction loss,

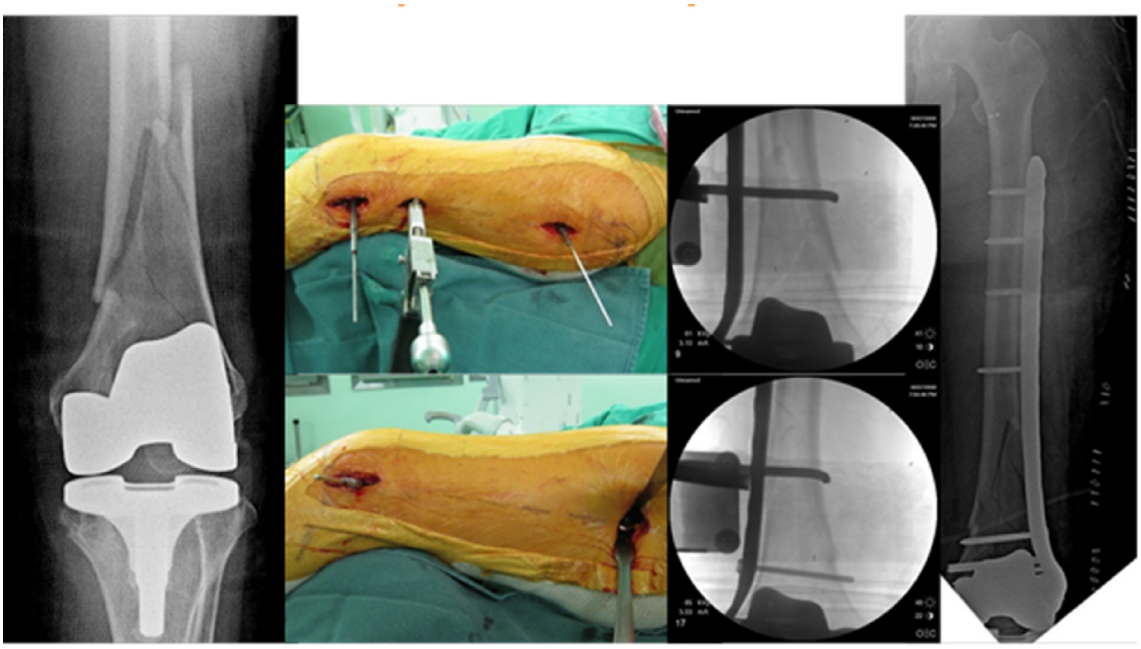

Fig. 1. The concept of minimally invasive plate osteosynthesis (MIPO). MIPO technique applied periprosthetic fracture at distal femur with minimal incision and biologic fixation.

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