

bone contain irregularly arranged lamellae and osteocytes interconnected by canaliculi. The nutrients diffuse through the canaliculi from capillaries in the endosteum surrounding the trabeculae, reaching the osteocytes.

Microstructural characteristics of both cancellous and cortical bone vary in function of the different skeletal sites, the gender, the age, and healthy conditions (Chen et al., 2010; Hildebrand et al., 1999; Macdonald et al., 2011). The introduction of 3D measurement techniques in bone research makes it possible to capture the actual architecture of cancellous bone. Krug et al. (2005) have shown that it is possible to determine structural parameters of the femoral trochanter and the femoral head in vivo by employing a high-resolution magnetic resonance (MR). More accurate results can be obtained in vivo employing high resolution peripheral quantitative computed tomography (HR-pQCT) (Macdonald et al., 2011; Dalzell et al., 2009; Cheung et al., 2013; Nishiyama and Shane, 2013; Link et al., 2003), but its application is restricted to peripheral sites such as the distal radius and distal tibia. Some examples of morphological properties of trabecular bone from different bone sites are summarized in Table 16.1.

16.2 PORE-GRADED BIOACTIVE GLASS-BASED STRUCTURES: A SHORT OVERVIEW

Tissue regeneration pursues the aim to stimulate the body's own mechanisms to restore damaged or diseased tissues to their original function or condition. Bone is often in need of regeneration due to trauma, tumors removal, defects filling, or age-related pathologies, such as osteoarthritis or osteoporosis (Salyer and Hall, 1989; Meadow, 2002; Schlickewei and Schlickewei, 2007). The substitution of large bone portions, also located in load-bearing bone segments, is one of the most important challenges in bone reconstructive surgery and has great importance for public health.

As illustrated in Section 16.1, bone tissue exhibits unique structural features, together with excellent mechanical properties and high hardness, due to its complex microarchitecture and hierarchical organization. The mechanical strength of bone depends on a wide variety of parameters, for example, harvest site, patient sex, age, health, and test conditions (Cowin, 1989); it was assessed and usually accepted a strength range within 2–12 MPa for cancellous bone, whereas the strength of cortical bone ranges within 50–500 MPa (Thompson and Hench, 1998). The presence and the amount of cortical and cancellous bone in the different bone segments of the human body are closely related to the function that the bone itself should accomplish (Goldstein, 1987).

Transplantations by using autografts or homografts have been traditionally adopted in orthopedics for bone repair (Salyer and Hall, 1989). Autografts represent the “gold standard” for bone substitutions, but they have limited availability and can cause death of healthy tissue at the donor site (Hoop et al., 1989). Homografts overcome the harvest drawbacks for the patient but can cause