We use this opportunity to review what we have done in the past 20 years in studying various metabolic bone disorders by bone biopsy. Before our investigation, the normal reference for bone histomorphometry had to be established as the basis for further study on bone quantity and bone quality from iliac crest biopsies of 259 normal Chinese subjects. Among them, there were 178 patients with minor orthopedic problems and 81 normal subjects who died suddenly. A total of 259 bone specimens was available for bone histomorphometric study.

In adults, bone consists of cortical and cancellous (trabecular) bone as well as bone marrow. The function of osteoclasts and osteoblasts in cancellous bone is controlled primarily by factors produced by adjacent bone marrow cells. Similar cells in Haversian systems of cortical bone are removed from the myriad of osteotropic cytokines that are produced by marrow mononuclear cells. Metabolic bone disease in adults is fundamentally a disorder of bone remodeling, which can be directly studied by performing histomorphometric analysis of undecalcified sections of trabecular bone from transiliac bone biopsies. Fluorochromes, such as tetracycline, can be given as tissue-time markers before the bone biopsy. The fluorescence of tetracycline uptake can be seen at the location where bone mineralization takes place near the cement line, showing a pattern of labels around the Haversian canal within the normal cortex and trabeculae. There is newly formed osteoid on the mineralizing surface containing double tetracycline labels. With better staining and embedding technique, under fluorescent microscopy, measurement of the distance between the two labels can be performed as well as osteoid seams width on the same undecalcified section.

Iliac bone specimens were studied from 114 normal Chinese subjects. Bone quality depends not only on bone volume and its 3D structure. In our study, only MTPS among the three calculated parameters showed a significant difference between the two categories of females at different ages. It suggests that MTPS might be a more sensitive parameter for predicting bone strength. It suggests that bone loss may be related to a sharp lowering of estrogen after menopause; thus, it is easier to understand why there are more compression fractures of vertebrae in females than in males. Bone dynamic parameters of normal subjects provide a basis for studying metabolic bone disorders. In this work, 62 normal Chinese subjects with age range of 22–60 years were divided into several groups on the basis of gender and age, including 28 women and 34 men. The possibility of a metabolic bone disorder had been ruled out before the experiment was started. On a specially designed schedule of 3-11-3-5 days double tetracycline labeling was undertaken and bone biopsies were performed below the
crest. The bone blocks were pre-stained with Villanova bone stain for 72 h and 10 μm undecalcified sections were made. Some of the sections were further stained with 1% toluidine blue. By light and fluorescent microscopy, the trabecular dynamic parameters were evaluated. On Villanova bone-stained section, the old mineralized bone was slightly green and the new bone showed dark staining. The osteoid was red and easy to differentiate from mineralized bone. The results indicated that there was a difference between male and female in mean osteoid seam width which was higher in males than females, but no significant difference was found between the two groups. It was probably caused by the imbalance of intrinsic hormone.

Bone mass changes with age. Bone mass reaches a peak in young adult life, but then steadily declines in both men and women. In women there is a rapid phase of bone loss, which is associated with estrogen withdrawal and lasts for about 10 years after menopause. The two critical determinants of bone mass are peak bone mass and rates of bone loss after mid-life. Since women have lower peak bone mass than men and lose bone rapidly because of estrogen withdrawal, bone mass in later life is less than it is in men. Loss of bone with age is a universal phenomenon in humans, the bone marrow cavity becomes larger, the cortex becomes thinner, and the trabeculae become decreased in number and size. Bone is lost mostly from the endosteal surface. The number of remodeling sites on the corticoendosteal or trabecular bone surface does not increase with age, nor does the ratio of resorption to formation site. The appositional rate and the tissue-level bone formation rate decreases, and so does the bone turnover rate. From these observations it has been concluded that age-related bone loss results from the summation of minute negative bone balances occurring within each individual microscopic site of bone turnover on the endosteal surfaces implying a preferential recruitment of osteoclasts over osteoblasts or in impairment of osteoblast function. A progressive loss of bone from the endosteal surface, however, leads to a second mechanism which accelerates or amplifies the first and renders the bone loss irreversible. As the plates and trabeculae become thinner than the depth of the resorption thrust, circular defects in the trabeculae occur and it is too extensive to refill again with new bone. In time, they add to a substantial net loss of trabecular bone and to erosion or trabeculation of the cortex.

Osteoporosis is a metabolic bone disease in which there is both a decrease in the amount of normally mineralized bone and disturbance in bone microarchitecture, with a consequent increase in bone fragility and susceptibility to fractures. The abnormalities in patients with osteoporosis include thinning and fragmentation of the trabecular bone plates; endosteal bone resorption leading to decreased cortical bone width and increased porosity of the Haversian canals. Bone loss associated with advanced age and estrogen deficiency in women is accompanied by a disturbance of bone microarchitecture. There is focal perforation of cancellous bone plates caused by osteoclastic resorption, leading to loss of connectivity of these plates and the presence of unconnected vertical rods and bars dispersed throughout the marrow cavity. The static and dynamic histomorphometric data collected from iliac bone biopsies do not differ greatly between subject with osteoporosis and the rest of the aging population. Some researchers consider osteoporosis to be an extension of physiological bone loss to the point of fracture, a quantitative but not qualitative difference from aging.