Primary hyperparathyroidism is more often found without any clinical important bone disease due to radioimmunological determination of serum parathyroid hormone and automatic screening of serum calcium (14). Morphological bone changes of these so-called mild forms of primary hyperparathyroidism were published by a few research groups only (1, 8, 10, 12). Periods of vitamin D deficiency were discussed as a pathogenic factor for the development of parathyroid adenomas (16, 8). Increased parathyroid hormone secretion influences bone cells and vitamin D metabolism. In primary hyperparathyroidism, changes of bone formation and mineralization can be expected in addition to increased bone resorption.

Our own experience with 32 patients with primary hyperparathyroidism is reported below. From the morphological point of view the following questions are of special interest: 1. Changes of bone structure, bone cells and mineralization, 2. Existence of skeletal development stages, 3. Bone changes following removal of the parathyroid adenoma.

PATIENTS AND METHODS
Iliac crest biopsies of 32 patients with surgical proven hyperparathyroidism were undecalcified embedded in methylmetacrylate (2), cut and stained (Goldner, Kossa, Giemsa, 10 μ). The parameters of bone structure, bone formation and bone resorption were determined by an integration eyepiece using the point counting method (9) as well as partly by an image analysing computer system (Zeiss Mikrovideomat). 60 cases without bone disease at the same age served as controls (3, 4). All data were statistically evaluated by a computer program. In addition, in 10 Institute of Pathology, University of Hamburg and Centre of Internal Medicine and Pediatrics, Department of Endocrinology and Metabolism, University of Ulm.
cases the serum parathyroid hormone concentrations were measured. 6 biopsies were prepared for electron microscopic investigation.

RESULTS

1. Bone structure: The structure of trabecular bone remained intact (6). In 3 cases we found an osteitis fibrosa only, but these cases were not considered in the histomorphometry because they had fibrous bone (woven bone) and not regular lamellar bone. The volume density (bone mass) and the specific bone surface were within the normal range (Fig. 1). The trabeculae were sometimes slightly broadened, but not thinner than in normal cases. The surface density (total bone surface) was increased due to resorption lacunae and channels in a few cases only (Fig. 1).

2. Bone formation: The osteoid volume was increased in 18 out of 28 cases. Nearly all patients had increased osteoblasts/osteoid interfaces and an increase of the total extent of osteoid seams (surface density of osteoid seams). The explanation for the increase of the osteoid volume and the surface of the osteoid seams could either be a disturbance of the bone mineralization or an increased synthesis of bone matrix with a normal mineralization process. There was a significant correlation between the osteoid volume and the surface density of the osteoblast/osteoid interface (Figs. 1 and 2). Olah (11) described the same finding in his cases with primary hyperparathyroidism and concluded that no mineralization disturbance exists. In our material, however, a few cases showed an increase of the osteoid volume without the same increase of the osteoblasts (Fig. 2). This must be the result of a defective mineralization. In the ultrastructure, the osteoblasts are active cells with a large number of cell organels and they produce collagen fibres. Within the osteoid lie many membrane-bounded vesicles, which represent the first stages of mineral deposit into the bone tissue (13). In contrast, in vitamin D deficient rats and in osteomalacia, an obvious reduction of these membrane-bound vesicles occurs. Therefore, in most of the cases we have no morphological substrate for a severe disturbance of mineralization.

3. Bone resorption: Size and form of the osteoclasts can differ considerably in primary hyperparathyroidism. Very large, and in other cases flat osteoclasts can be observed. The parameters of bone resorption — surface density of the osteoclast/bone interface, the total extent of Howships lacunae and the index of osteoclasts showed a considerable variation in our studies (Fig. 1). The index of osteoclasts correlated with the serum parathyroid hormone concentration as reported by other authors. There was, however, no correlation between the interface osteoclasts/bone and osteoblasts/osteoid. The age of the patients might determine whether the