5 Osteogenesis and Hematopoiesis

In the data presented in the foregoing chapters, we have demonstrated that osteogenesis during fracture healing and regenerate formation depends upon the degree of preservation of the osteogenic elements of the bone marrow and upon the integrity of the nutrient artery and its branches. Considering the bone-forming potential of bone marrow, we thought it worthwhile to investigate the relationship between the marrow’s osteogenic potential and its hematopoietic activity. Active osteogenesis is replaced by active hematopoiesis as the function of the marrow becomes normal during the remodeling phase of new bone formation.

During the 2nd week of distraction of a corticotomy site, bone marrow hematopoietic cells are present in the cavities of the regenerate in the form of several cell lines, including the precursors of erythrocytes – the erythroblasts – at various stages of development (Fig. 5.1), and the precursors of the monocytes – the monoblasts (Fig. 5.2). Also present are myelocytes, which are precursors of the
granulocyte line (Fig. 5.3). The process of hematopoiesis in the regenerate bone continues during the stage of fixation into the subsequent period of regenerate remodeling (Fig. 5.4).

This close relationship between the hematopoietic and osteogenic cellular elements of the marrow suggests that these two cell populations may arise from a common genetic origin. To assess this possibility, we performed the following experiment in two groups of rabbits. First, we created a 5-mm-wide defect in the fibulae of animals in both groups. In the first group, the fibular defect was created 1 h after bleeding the animal of a quantity of blood equal to 1% of its body mass. In the second group, the fibular defect was created, but there was no preoperative phlebotomy. Thereafter, in both groups of animals, the osteogenic processes in the fibular defects were studied (Fig. 5.5). In the experimental group the fibular defect was filled in more rapidly than in the control group (Figs. 5.6, 5.7). Specifically, in the group undergoing preoperative phlebotomy the fibular defect was filled in by the 21st postoperative day, in the control group not until the 35th day.

Radioimmunoassay research confirmed that the stimulation of osteogenesis caused by preliminary blood loss was characterized by an increase in the concentration of cyclic adenosine 3,5-monophosphate (AMP) compared to the control group (Fig. 5.8). (Cyclic

Fig. 5.4 a, b
a Erythroblasts at 1 month of fixation
b Erythroblasts 1 month after fixator removal

Fig. 5.5 a, b
Fibular defect experiment
a Experimental group
b Control group