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HALO VOLUME: INTRODUCTION TO QUALITATIVE STUDIES

HAROLD M. FROST, M.D.

The existence of halo volume has been reported previously. In brief, halo volume has been described as a quasipermeable shell of bone surrounding the osteocyte. The shell is the bony wall of the lacuna. The quasipermeability is somehow maintained by the living functions of the osteocyte and disappears after death of the osteocyte.

The significance of halo volume is simple; it is the key to our future understanding of the osteocyte, and it is the locus of rapid exchange processes between bone and blood.

Why study the osteocyte, of all things?

Osteocytes hold the key to a myriad of functions we are just becoming aware of. In a real sense the osteocytes in one's body are a living cellular mass interposed between bone and blood. What exchanges between bone and blood is governed by these cells, and the exchange may involve buffers during severe illness, calcium and phosphate in different types of illness, and toxic bone seeking ions or molecules. To make this gatekeeper do our bidding we must learn its coinage.

One of the trigger mechanisms setting off repair of microcracks is probably osteocytes stimulated in some manner by the cracks. One of the triggers to the normal remodelling of the skeleton which goes on all during life is the osteocyte. Data from this laboratory indicate that changes in the osteocytes are associated with aging and are associated with cardiac failure, particularly fibrillation, the meaning and mechanism of these associations not being known at present.

Ca suffit.

A series of brief papers follow, representing several approaches to the osteocyte problem. It is obvious that we do not fully understand the nature of halo volume, nor the nature of the osteocyte's functions. A great deal of work and thought must be given to the subject before clarity is achieved.

The reader might keep in mind, while reading the following material, the following generalizations:

A) The osteocyte lives in an unusual physical environment consisting of a small hole in dense, impermeable bone. The hole is connected to a source of blood supply by a system of elongated, tortuous tubes of small diameter. The result of this physical environment is that the osteocyte experiences peculiar diffusion problems in getting

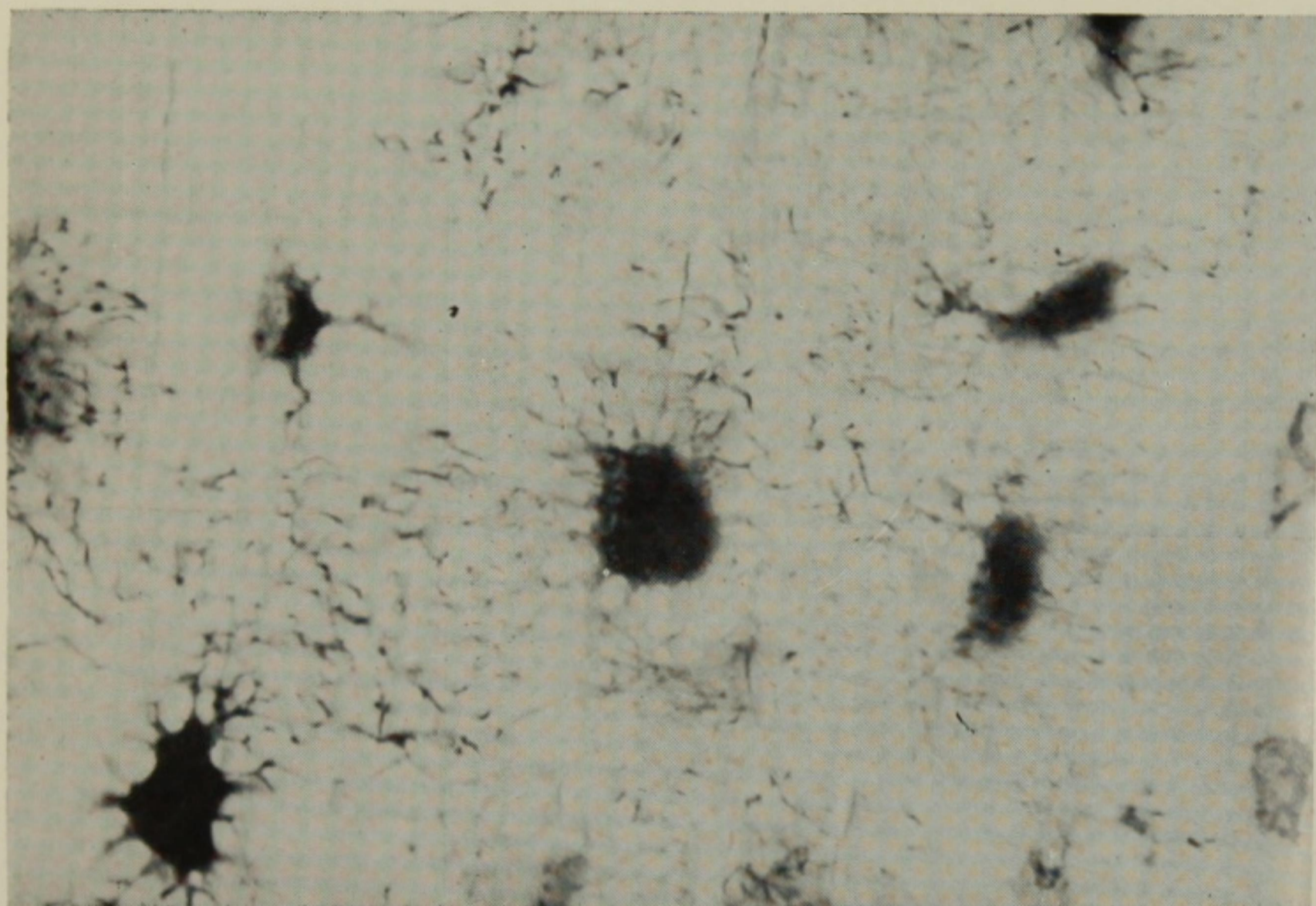


Figure 1

About 600 X, undecalcified human bone, basic fuchsin. This photomicrograph renders a true picture of the relative sizes of the spaces in bone termed osteocyte lacunae and canaliculae. Mineralized bone matrix has prevented permeation of the molecules of basic fuchsin into the matrix. The stain is confined to the lumens of the spaces named, and to the walls of these spaces.

hold of anabolic substances and in getting rid of catabolic substances.

B) The nature of the bony wall of the osteocyte's prison is in turn peculiar. We are just beginning to attack the problem of defining the nature of the bony wall, which we term halo volume. (Fig. 1, 2)

C) The metabolism of the osteocyte is different from that of other cells. Whether this is inherent in the cell or the result of its unusual chemical and physical environment or both remains to be seen.

D) Study of osteocyte metabolism may thus be broken up into study of the nature of the spaces in which the osteocyte resides, the nature of the walls of these spaces, and the nature of the cell biochemistry.

The bibliography follows part IV of this series.

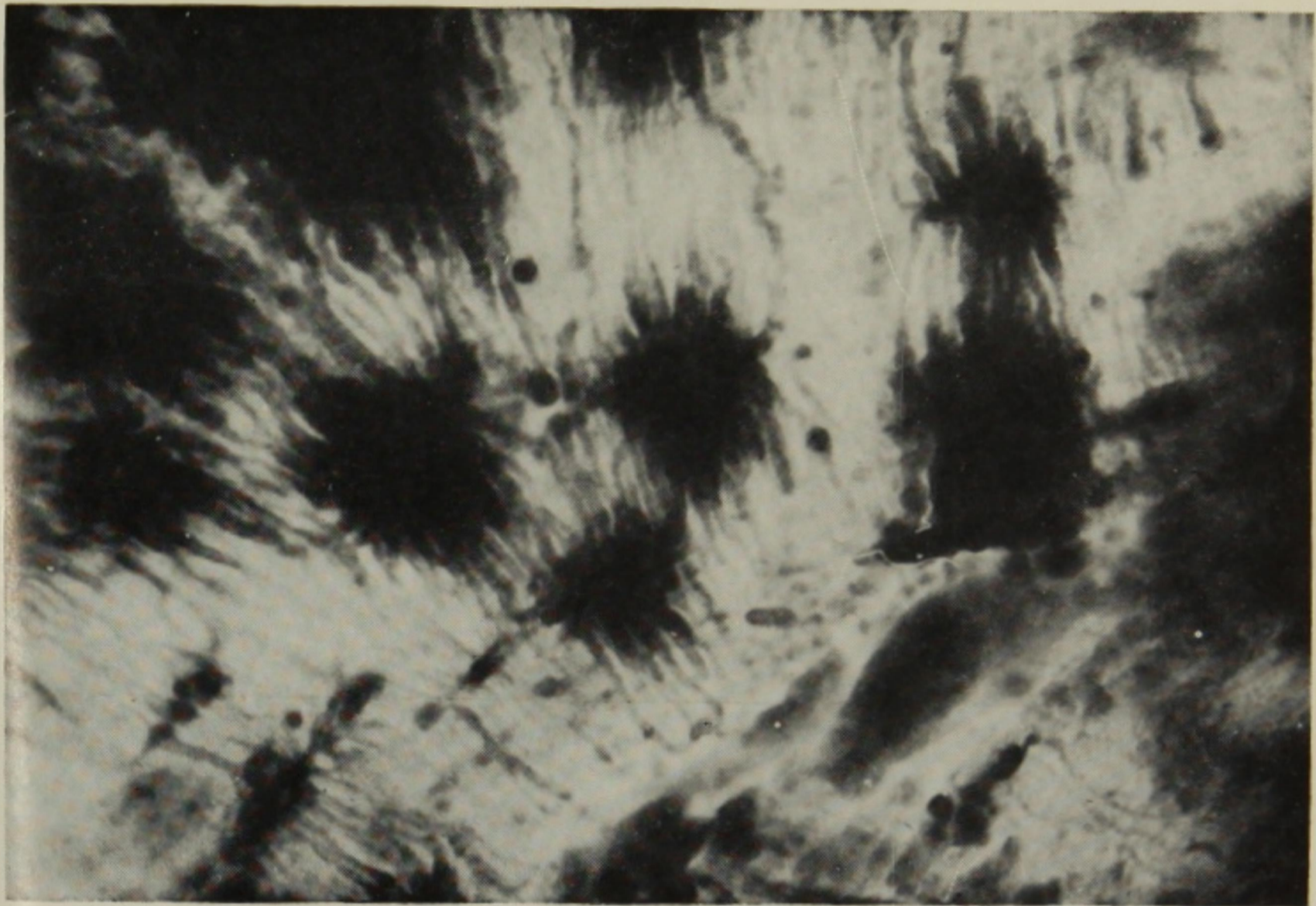


Figure 2

Same magnification, section of same bone but stained for halo volume characteristic by the writer's permanganate method. The lacunae appear fatter, and the parts of the canaliculae close to the lacunae appear larger in diameter, because the permanganate has permeated a short distance *into* the wall of the lacunae and canaliculae. While small ions such as permanganate may permeate in this manner, large molecules such as fuchsin cannot. This selective permeability, in part due to an effect of ionic radius, disappears when the osteocyte in the lacuna dies. The permeability may be decreased or increased by certain observed but not understood effects upon the metabolism of the osteocyte in the lacuna.