I recommend that more investigators carry on experimental work utilizing animal joints and that they design their equipment to obtain instantaneous data at every point in a cycle of operation. I further suggest that they will find an extremely complex problem and many more facets to investigate than proposed to date. To those who undertake such investigations, may they have the fortitude to come up with answers so as to relieve or eliminate the suffering of millions of people from the scourge of arthritis.

Additional References


67 Index of Rheumatology, American Rheumatism Association, New York.


Author's Closure

The author wishes to thank Mr. F. C. Linn for some of his worthwhile and elucidatory comments. In particular items 2 and 3 were very much appreciated. However the author feels that the discusser missed the spirit of the article and hence he will take this opportunity to clarify this situation.

First of all it was not the intention of the author to write a compendium on the subject of synovial joints. Simply the intent was to present relevant facts pertaining to the mechanical properties of the constituents and possible ways of describing them. Secondly, in regards to comment 1, it seems that at present there is indeed much confusion concerning the porous nature of the cartilage. To verify this statement I would like to quote from the discusser's own paper [29]:

"The flow rate of the fluid through the colloid matrix must be governed by a number of factors: the cross sectional area, continuity and direction (isotropism) of the pores of the matrix..."

"The viscoelastic properties of the matrix, including collagen, may also contribute to the flow rate by affecting the pore size."

However, since the approach is phenomenological, the exact nature of the pores, or in general the microscopic structure, is of no importance. This is a fundamental assumption, which one accepts, and is universal to all studies in elasticity, fluid mechanics, etc.

Finally the problem suggested by Mr. Linn in his item 4 is just an example of that suggested by the author's item 5. To wit, consider a layered half space. The top layer is defined by a fluid-filled poro-elastic medium. This phenomenologically describes the behavior of cartilage. The lower half space representing the impervious bone is characterized by an elastic medium. To simulate the reciprocating nature of the motion found within diarthrodial joints, the following boundary conditions may be imposed:

\[ p^b = \sigma(x) e^{-yt}, \]
\[ \sigma_n = 0, \quad y = 0 \]

where \( y = 0 \) defines the free surface of the cartilage. Here \( p^b \) is the pore pressure on the surface of the cartilage, \( \sigma(x) \) is an integrable function, \( \sigma_n \) is the stress tensor of the elastic matrix of the porous-elastic layer, and \( u \) is a typical frequency of joint motion. The governing equations of the poro-elastic layer sub-
jected to these boundary conditions constitute a particular squeeze film problem. If the solution of this squeeze film problem shows that there is a build up of pore pressure in the poro-elastic layer then the postulated "self-induced hydrostatic pressure" will exist in the cartilage. Hence we see that "self-induced hydrostatic pressure" is a result of more fundamental considerations. To this end, the recent investigation of M. C. Mow and F. F. Ling shows that for steadily moving arbitrary loads on the above mentioned system, the poro-elastic medium is capable of sustaining a large hydrostatic pressure within the layer. Hence we see that "self-induced hydrostatic pressure" is a result of more fundamental considerations. To this end, the recent investigation of M. C. Mow and F. F. Ling shows that for steadily moving arbitrary loads on the above mentioned system, the poro-elastic medium is capable of sustaining a large hydrostatic pressure within the layer.