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HEBERDEN SOCIETY

CLINICAL MEETING.—At a meeting held on May 17, 1968, at Glasgow, the following papers were presented:

Lubrication of Human Joints. By P. S. WALKER, D. DOWSON, M. D. LONGFIELD, and V. WRIGHT (*Rheumatism Research Unit and Department of Mechanical Engineering, University of Leeds*).—The overall geometry of the hip joint was determined by casting techniques and the fine surface finish by means of Talysurf measurements. A reciprocating machine was constructed and used to measure the friction of joint cartilage under boundary lubrication conditions and to evaluate squeeze film times.

It was demonstrated that:

(1) In the normal hip joint, contact is around a horseshoe area.
(2) The fine surface quality of cartilage is rough by engineering standards.
(3) The cartilage surfaces in the hip are likely to be separated by squeeze films for prolonged periods under load.
(4) By comparing squeeze film times of cartilage with rubber, it appears that the fluid between loaded cartilage surfaces becomes more viscous than the overall synovial fluid. This may well be due to the porosity of cartilage.
(5) During walking, fluid films are set up by elastrohydrodynamic action in the swing phase and during the loaded phase are maintained by squeeze film action. It is suggested that a mechanism of "fluid entrapment" operates in the lubrication mechanism of joints.
(6) Osteoarthritic surfaces do not display such a great squeeze film as normal joint surfaces in some conditions, because of the surface quality.

Visco-elastic Properties of Some Pathological Human Synovial Fluids. By D. V. DAVIES and A. J. PALFREY (*St. Thomas's Hospital Medical School, London*).—Human synovial fluid can be obtained in quantity only from joints in which there is an effusion resulting from some pre-existing disease. Such fluids have been studied in the Wiessenberg rheogoniometer, a cone and plate viscometer in which any force normal to the platens can be measured while maintaining the geometry of the fluid filled space. The viscosities of these abnormal fluids are less than those of normal bovine fluids, and there is evidence to suggest that lower values are obtained in fluid from patients with rheumatoid arthritis than in those with osteoarthritis. Forces occur in bovine synovial fluids which tend either to separate or approximate the platens during the different phases of the period of rotation; similar forces occur in some human fluids, though they are reduced in magnitude. The phenomenon of immediate viscosity, previously described in detail for some of the more viscous bovine fluids, is only found uncommonly in these human fluids. These two factors suggest that there may be changes in the elastic properties of the fluids as well as a reduction in their viscosity. The use of these observations as a basis for diagnostic and prognostic decisions in clinical work, together with the correlation between these changes and the biochemical changes known to occur in synovial fluid from diseased joints, was discussed.

Rheology of Synovial Fluids: Behaviour in Rheumatoid Arthritis and Some Possible Interpretations. By J. FERGUSON and J. A. BOYLE (*Department of Fibre Science, University of Strathclyde, and the Centre for Rheumatic Diseases, Glasgow*).—Much effort has recently been put into the investigation of the rheology (*i.e.* the flow behaviour) of synovial fluid, and the unique flow characteristics of synovial fluid are now being discovered. This paper described the flow characteristics of synovial fluid from osteoarthritic knee joints and compared them with those of fluid from rheumatoid arthritic joints.

Our recent work on patients suffering from osteoarthritis has shown that synovial fluid is of comparatively high viscosity, highly non-Newtonian, and extremely elastic. Mowever, it appears to exhibit a unique form of thixotropy. At low shear yield, stresses are encountered in the direction of shearing: at high shear these disappear, and large yield stresses appear in a direction normal to the direction of shear. These effects have not been described before for human joints.

A comparison with rheumatoid joint synovial fluid shows that this is of lower viscosity, more Newtonian, and non-elastic, and that the peak stresses do not appear. The viscosity, in fact, would appear to be related to the severity of the condition.

Two theories at present exist which purport to explain these phenomena. It is generally accepted that the flow behaviour is dominated by the hyaluronic acid/protein complex concentration. One theory is that in rheumatoid joints the complex exists in a degraded form. The other suggests that the molecules are not degraded but that the complex has dissociated. These theories were compared in the light of our experimental data and a third possibility was considered, namely that the effect might be largely one of dilution. The experiments to distinguish between the theories were described.

The physical chemistry of solutions which show the type of behaviour encountered in synovial fluid was discussed in detail and the applicability of this to flow behaviour of synovial fluid *in vivo* was considered.

Discussion.—PROF. J. J. R. DUTHIE (*Edinburgh*): I have always surmised that in osteoarthritis there was something wrong with the lubrication of cartilage.