George Kernohan BES 25th Anniversary

PARAMETERS OF PHYSIOLOGICAL PATELLOFEMORAL CREPITUS

D.E. Beverland, W.G. Kernohan, R.A.B. Mollan
Department of Orthopaedic Surgery
The Queen's University of Belfast
Belfast, BT9 7JB

When the normal knee is moved slowly, a vibration is produced that can be felt on the patella. This phenomenon we have called "physiological patellofemoral crepitus" (P.P.C.); problems with analysis of this signal are discussed elsewhere (1). We have been using an accelerometer based computer system to investigate these vibrations. This poster illustrates how the response of the accelerometer predicts the direction of movement of the patella. Using this information it has been shown that the patella vibrates like a see-saw, as the upper pole moves out the lower pole moves in. The difference in waveform between the upper and lower poles of the patella is shown in figure 1.

Using a model of the patellofemoral joint the apparent paradoxical nature of this movement can be explained. The model is illustrated in figure 2; as the wheel is rotated clockwise the model patella initially sticks to it and tends to rotate in an opposite direction, like two cog-wheels in contact. This rotation continues until the static friction between the two is overcome and the model patella slips. It is this sudden slip that is detected by the accelerometers that produces the P.P.C. signal. The initial, more gradual, rotation is the stick phase which is not detected.

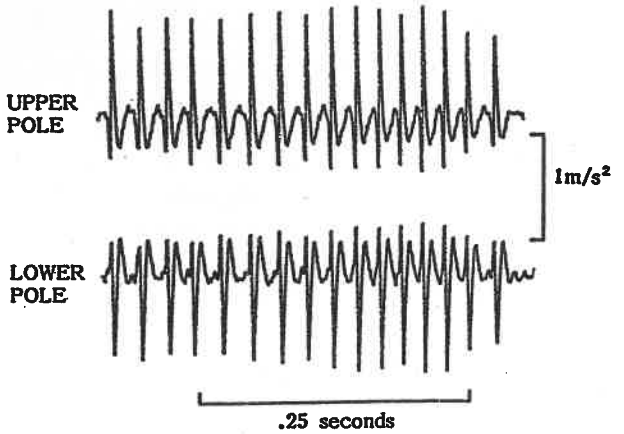

Fig. 1

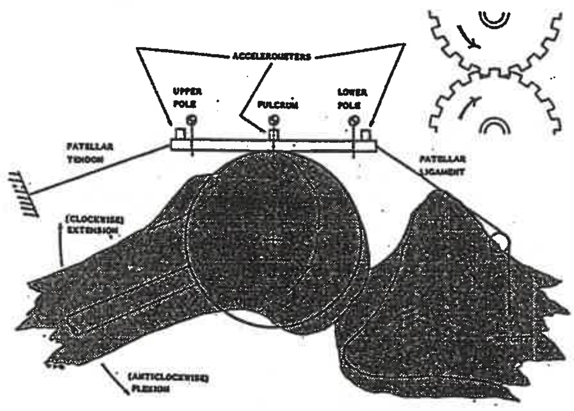

Fig. 2

P.P.C. is produced when the normal knee is moved slowly, up to a maximum angular velocity of ten degrees per second. The repetition rate of P.P.C. is directly proportional to the angular velocity. This is illustrated in figure 3, where the lower trace is from an angular displacement transducer which was attached to the leg in the form of a goniometer. The slope of the line gives the angular velocity. When the displacement trace is flat there is zero angular velocity and no P.P.C. signal. Conversely if the slope becomes too great the signal again stops. By developing an apparatus to move the knee at a constant angular velocity we hope to be able to produce a controlled signal.

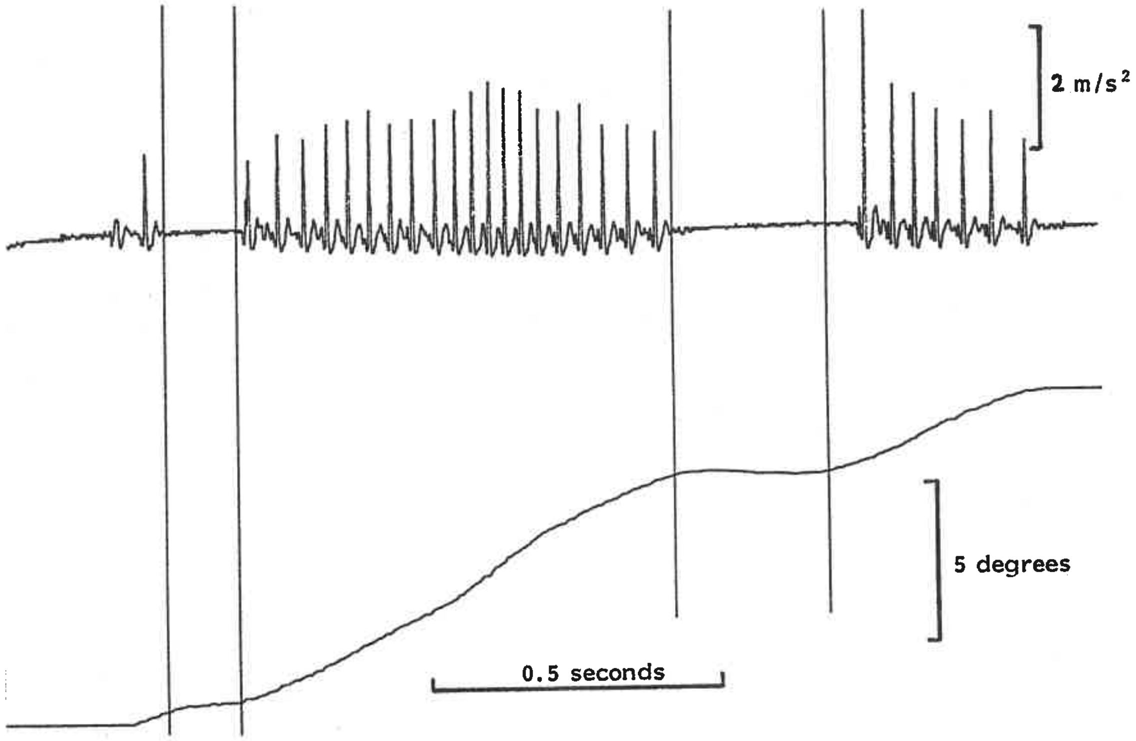

Fig. 3

During loading of the knee joint, as in weight-bearing, the inherent and slip frequency of P.P.C. is increased. However after isometric loading the amplitude is very significantly increased often by a factor of ten. Figure 4 shows the comparison in amplitude between baseline P.P.C. following a period of rest, and that following isometric load when the knee is relaxed again. This is thought to represent the effects of cartilage deformation that are known to occur under load. This provides the potential for a sensitive indicator of the physical properties of articular cartilage. Finally the effect of pathology on P.P.C. will be demonstrated to show the potential importance of this non-invasive investigative tool in the evaluation of joint problems.

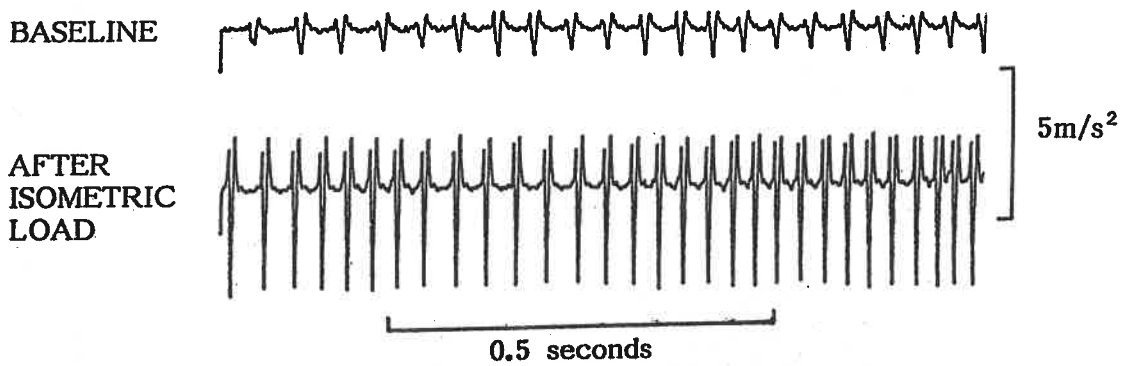

Fig. 4

1 Beverland, D.E., Kernohan, W.G., Mollan, R.A.B. "Analysis of physiological patellofemoral crepitus" Proc. Biological Eng.Soc. Cambridge, 1985.