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TEMPERATURE REGULATION IN A BIOLOGY JOINT

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INTRODUCTION

Intraarticular generation of heat is expected in any joint mechanical or biological due to frictional resistance of its components [Bowden and Tabor (1967)] during movement and work.

Wear of a joint being proportional to frictional resistance, consequently depend on the effects of heat-the more heat is produced the more wear occurs with disorganization of the joint and functional impairment.

(a) Cooling Mechanism in Machine Joint

In a mechanical joint, the components of which can be easily replaced, there is always a necessary cooling mechanism to protect its components from the effects of heat produced.

(b) Protective Inbuilt Mechanism in Biological Joint

In a biological (animal) joint, because the components cannot be easily replaced, nature has made some protection in built mechanism, so that the components of the joint can last at least the biological span of 3 crores years and ten in a human being. Some of these mechanisms are known but others are still unknown factors. They are

(i) Efficiency of Synovial Fluid : The lubricating synovial fluid because of its thixotropic or anom alous viscosity is more efficient than any machine lubricating fluid. Its protein content particularly hyaluronate produces this property of thixopropy *i.e.* the grade of the lubricating fluid becomes less viscous in dynamic conditions like the modern multigrade mobile oil. The glycoprotein molecules of synovial fluid stick to cartilage bearing surfaces to provide boundary.

(ii) Efficiency of mechanism of lubrication : The mechanism of lubrication are varied and complex bondary and different forms of fluid flim lubrication depending upon static phases of joint movement in contrast to the fluid flim (hydrostatic and

hydrodynamic) lubrication in a mechanical joint [Charnley {1959}]. The boundary lubrication seems to be a misnomer and it should be more appropriately termed as surface lubrication.

(iii) Efficiency of Articular Components : The biological role of articular cartilage is unique in contrast to the metal/plastic bearing surface of a machine joint. The articular cartilage by its viscoelastic, smooth water locatable surface minimize friction to a minimum. The viscoelastic bearing surface of a biological joint, is unique and has not yet been achieved in any mechanical joint. The coefficient of friction in a biological joint is estimated to about 0.001 [Radian and Paul (1972)], which is much less than that of any best mechanical joint where it is 0.024. Another unique property is that the coefficient of friction does not increase with loading as in a mechanical joint but on the other hand becomes less with loading of the jont [Radin and Paul (1972)].

(iv) Frictional Heat Generation And Its Control : Inspite of the near perfect mechanism to minimise friction as low as 0.001 [Radin and Paul (1972)] in a biological joint, there is still some possibility of heat generation. The production of heat in a normal biological joint and its regulation has not been men mentioned or stressed or stressed for in available literature.

The object of this study is to quantity the intraarticullar heat generation in adult human knee joints after standard set of exercise/movement and also to write if there is an inbuilt mechanism of joint temperature regulation after work exercise.

MATERIALS AND METHODS

In six young healthy adult volunteers in the age group twenties ware taken for study . Two 7.5 cm long needles of 22 size were introduced one in knee joint space and the other to the subchondral cancellus bone in lower end of femur. The skin temperature was noted before introduction of needle. Intraaticular temperature and subchondral bone temperature were noted at rest and immediately after standard set of resistance flexion and extension exercise are also after 5 minutes after completion of exercise. The temperatures were noted by a sensitive thermocouple.

RESULTS

The data results of the experiment are given in Table 1

TABLE 1

	REST		AFTER EXERCISE	
	I.A.	**Subchondral**	**I.A.**	**Subchondral**
Male 22 yrs rt	30.3°C	30.3°C	30.3°C	31.0°C
Male 26 yrs rt	29.9°C	30.0°C	30.3°C	31.3°C
Male 24 yrs rt	31.2°C	31.5°C	31.3°C	32.2°C
Male 26 yrs rt	29.5°C	30.5°C	30.4°C	31.6°C
Male 26 yrs rt	31.0°C	31.9°C	31.0°C	31.9°C
Male 19 yrs rt	29.4°C	30.3°C	29.9°C	31.0°C

Air Conditioned room temperature-75°C

OBSERVATIONS

It is observed in this study that there is hardly any rise of intraart cular temperature immediately after standard set of exercise in normal human knee joint but the temperature of subchondral bone is raised to nearly 1°C immediately after completion of exercise which normalize in about 5 minutes after completion of exercise.

DISCUSSION

The findings suggest that there is an inbuild consequent cooling (air condition) mechanism in a normal biological joint to protect it from biological heat and consequent wear. The possible hypothesis of this cooling mechanism is that subchondral bone seems to absorb the heat by direct circulation of heated synovial fluid through its pores each 60° A [McCutchen (1959)]. The highly vascular cancellus subchondral bone ultimately taking up the heat from synovial fluid by conduction.

Cartilage pores after being cooled into the joint cavity (weeping or self pressurized mechanism of fluid lubrication), [Eadian and Paul (1971,1972)].

This cycle of circulation of synovial fluid, apart from its important role in joint lubrication of articular cartilage serves as inbuilt mechanism of temperature regulation in biological joint.

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