2) *Characteristics of the Dermal Connective Tissue Which Seem to Determine the BP Values*

(1) The Dermis Acts as a Reservoir for Electrolytes

The dermal connective tissue has the capacity to act as a reservoir for electrolytes in accordance with its particular protein–saccharide polyelectrolyte composition. This property is thought to be of particular significance for the sodium ion (Na^+) and chloride ion (Cl^-) content of this connective tissue.[5]

(2) The Hyaluronic Acid Network with Its High Negative Electrical Charge Functions as an Ion–Exchanger

Since at physiological pH each glucopyranuronosyl residue of the repeating hyaluronic acid unit carries a free carboxyl group, the network of hyaluronic acid confers a considerable fixed negative electrical charge onto the interstitium. This enables the network to function as an ion exchanger and controls the diffusion of many metabolites through the ground substance. Changes in the character of hyaluronic acid network are also thought to alter the distribution of inorganic ions in the network.[4],[5]

(3) A Close Relationship Exists Between the Overall Immobile Charge Possessed by Macromolecular Species of the Interstitium and Sodium Ion (Na^+) Content

Furthermore, shifts in the sodium ion (Na^+) content of the interstitium also induce changes in the character of the various polyelectrolytes.

(4) A Close Relationship Exists between Mucopolysaccharide Composition and Inorganic Ion Composition

Thus, there exists a close inter–relationship between protein, polysaccha–

ride and inorganic ion (Na^+, K^+, Ca^{2+}, Cl^-, etc.) content in the dermal connective tissue.

Some further consequences of these interrelationships are listed below: Hyaluronic acid and dermatan sulfate, by virtue of their free carboxyl and sulfate radicals respectively, behave as polyanions which can bind cations such as Na^+, K^+, Mg^{2+}, Ca^{2+} etc. This role is thought to be of particular significance to the sodium and chloride content of the extracellular space and to the general regulation of water and various electrolytes.[(4),(5)]

Excess sodium in the connective tissue is stored as a counter ion for mucopolysaccharide anions.[(5)] Moreover, it is known that changes in the concentration of the sodium ion (Na^+) in a solution of hyaluronic acid induce conformational changes in this macromolecule; at low salt concentrations it assumes a compact coil-like structure and at higher salt concentrations a more 'unwound' structure.[(4)]

(5) A Close Relationship Exists between Hyaluronic Acid Composition, Na^+ Content and Water Metabolism - Relationship between Hyaluronic Acid and BP Value

As already stated, hyaluronic acid is known to play an important part in sodium ion accumulation and water content in the ground substance of connective tissues, thus playing a role in the systemic control of the water content. In previous sections, it was surmised that the BP current flows in the water-rich phase of the ground substance of the connective tissue. Therefore it seems probable that the state of hyaluronic acid (in association with sodium ion) will in turn determine the electrical character of the dermal connective tissue (water-rich phase) and therefore influence its BP value.

(6) The Character and Concentration of Hyaluronic Acid in the Ground Substance Determines the Ratio of Water-Rich Phase to Water-Poor Phase. This in Turn Influences the BP Value

As another factor influencing the BP value we will now consider the ratio between the water-rich and the water-poor phases in the ground substance.

From electrometric studies on various connective tissues, Joseph et al showed that the relative ratio of the water-rich phase to the water-poor phase automatically determines the relative ratios of various ionic species in the ground substance.[(5)] As already mentioned, it seems probable that it is in fact hyaluronic acid which plays the predominant role in determining this ratio between the water-rich and water-poor phases.

Viewed in another way, since hyaluronic acid is the main component of the ground substance, the material through which all metabolites to and from the cells must pass, functional changes in the state of the hyaluronic acid (average molecular weight, concentration, etc.) will necessarily result in changes in the distribution of many metabolites and ions in the ground substance.

Table G: The Monthly Variation of Average BP Values (Dec.1974 – Nov. 1975)

Month	Number of Sub.	BP	Month	Number of Sub.	BP
1	63	966.31	7	110	1105.14
2	80	970.75	8	94	1130.20
3	59	996.01	9	95	1090.18
4	84	967.69	10	101	1050.81
5	109	986.54	11	66	1039.93
6	78	1039.08	12	77	960.43
			Ave.	1016	1030.77

In any case, irrespective of the actual mechanisms involved it seems probable that changes in the state of hyaluronic acid in the ground substance cause shifts in the ratio of the two phases and consequently in the ionic content of this medium. Therefore it follows that BP current flow through the ground substance of dermal connective tissue will also be changed.

It is well–known that the water content of the dermal connective tissue is higher in summer than in winter and this coincides with the observation that the BP values from measured AMI data show higher values in summer than in winter. Therefore it seems likely that the water and ionic content (esp. Na^+) of the ground substance will increase in summer in conjunction with distribution changes of other ions. The monthly variation of average BP values is displayed in Table G.

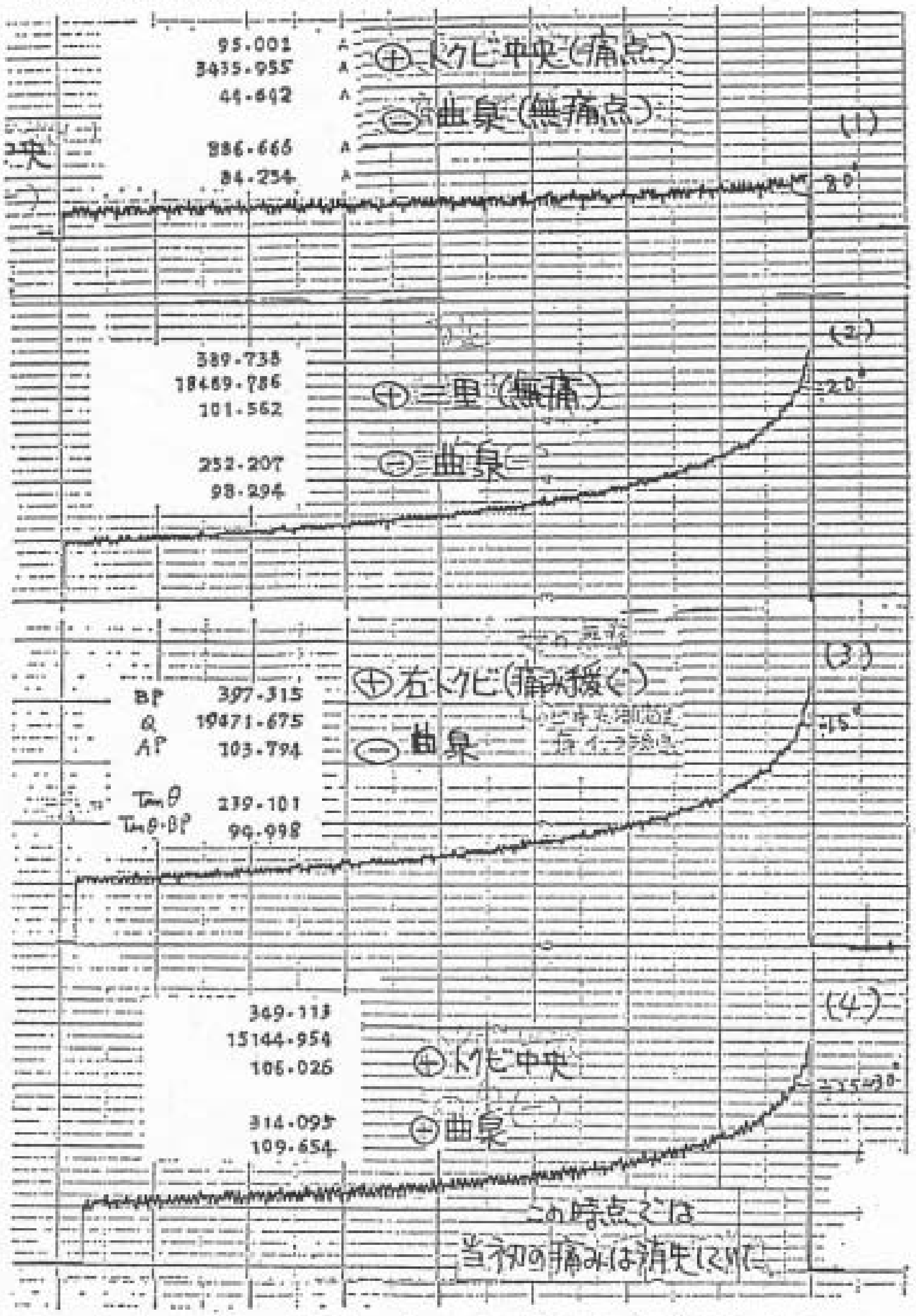
(7) The Character and Concentration of Hyaluronic Acid in Synovial Fluid (a Connective Tissue) Plays an Important Role in Rheumatoid Arthritis. This Is Reflected in BP Value Changes

Next we shall explain, through the use of an example, another property of hyaluronic acid which is thought to be reflected in the BP value.

It is well–known that hyaluronic acid is responsible for the high viscosity and lubricant properties of synovia produced in joint cavities, saccate cavities and synovial sheaths (e.g. vagina tendinis). Moreover, disturbances in the average molecular weight or concentration of hyaluronic acid in this synovia are known to play a very important role in the development of arthritis and rheumatoid arthritis.

Prior to one of our own electrometric studies, the subject, an Indian woman aged 54 years, had suffered from rheumatoid arthritis in the knee joint. As in the experiment in the previous section, the instrumentation used was an 842 wave memory operating in conjunction with the extended AMI unit. Each measurement involved the insertion of two insulated needle electrodes (insertion length 5mm, exposed metal tip 1mm) to a depth of 2 – 3mm at two

Subject: P.D.P. (♀), Age 54, Sept. 1979, Applied Voltage: 1.0 Volt; 10 msec



(1) (+) needle electrode inserted into a site centered between the Tokubi points on the right leg (ST35 and an extraordinary point) – painful site
(–) needle electrode inserted into right Kyokusen (LV8) point – non-painful site

(2) (+) needle electrode inserted into right Sanri (ST36) – non-painful site
(–) needle electrode inserted into right LV8 – non-painful site

(3) (+) needle electrode inserted into right lateral ST35 – pain somewhat diminished
(–) needle electrode inserted into right LV8 – non-painful site

(4) (+) needle electrode inserted into a site central between the two Tokubi points on the right leg (ST35 and an extraordinary point) – prior to this stimulation the pain had disappeared
(–) needle electrode inserted into right LV8 – non-painful site

Figure 3: Current–Response Curves from Painful Versus Non–Painful Sites

chosen sites. Current–response curves (to an applied 1.0 volt 10msec pulse) were recorded between the painful site and compared to the responses from nearby non–painful sites and the same reference site. The various current–response recordings are shown in Figure 3.

Referring to these recordings, it is apparent that the initial measurement involving the painful site has a very low BP (and IQ) value compared to non–painful sites. This can be attributed to changes in the distribution of water and ions at the painful site associated with disturbances in the state of hyaluronic acid, this being reflected by an abnormal BP (and IQ) value.

Thus the above example is consistent with the concept that the value of the BP current (which predominantly flows in the dermis) is greatly influenced by the state of the ground substance mucopolysaccharide (esp. hyaluronic acid) in association with the water and ionic content of this medium.

In the next section we shall move on to consider in more detail the fundamental physical nature of the BP current flowing in the ground substance.