noon, and +0.96 at 6 p.m. Consequently, at 6 p.m. (when the mitochondria reached their largest size) this correlation became strong, positive, and significant. Moreover, strong correlation (r = +0.88) was found between the volume of the mitochondria and the degree of correlation between VP_r and VP_{max} of the left ventricle. In other words, the more normal the volume of the mitochondria, the stronger the correlation between the real and maximal attainable function of the left ventricular myocardium, i.e., the more synchronized the working of the myocytes of the left ventricle. Since swelling of the mitochondria leads to increased energy production by them, it can be postulated that an excess of this energy is utilized for processes determining this synchronization. According to this point of view it can be concluded that at 6 p.m. the heart muscle functions optimally compared with other times of the 24-h period studied.

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REACTIVE MOBILITY OF DENDRITES

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Normal or increased peristaltic activity of the intestine may provide an adequate mechanical factor to which neurons of the autonomic nervous system can react. It was in fact shown some time ago by neurohistological methods that the nervous system of hollow organs capable of mechanical activity is characterized by a special kind of change in the dendrites, known as "overflows of neuroplasm" [3, 6, 7]. The concept of overflows of neuroplasm is in harmony with data on the proximal-distal flow of neuroplasm and it may be regarded as a reactive state, although it is often found in completely normal animals [5, 10, 14]. The frequency of this phenomenon is known to be increased under experimental conditions [2, 4, 6]. Many neurons with changes of this kind have been found in experiments with gravitational overloads. On the basis of fixed preparations, the dynamics and mechanisms of this phenomenon can only be conjectured, and this process has not hitherto been studied in living objects.

Accordingly, in the investigation described below, an attempt was made to compare neurohistologic data on the nonspecific reactive phenomenon of overflows of neuroplasm with intravital observations on reactive mobility of dendrites of surviving neurons or nerve cells in tissue culture.

EXPERIMENTAL METHOD

Neurons of the large intestine of 12 rabbits and five cats, exposed to functionally tolerable overloads of up to 8g according to a special graph, were studied. The direction of the overloads was: head–pelvis, pelvis–head, chest–spine, spine–chest. The material (total preparations of intestine) was processes by the Gomori or Bielschowsky–Gros methods.

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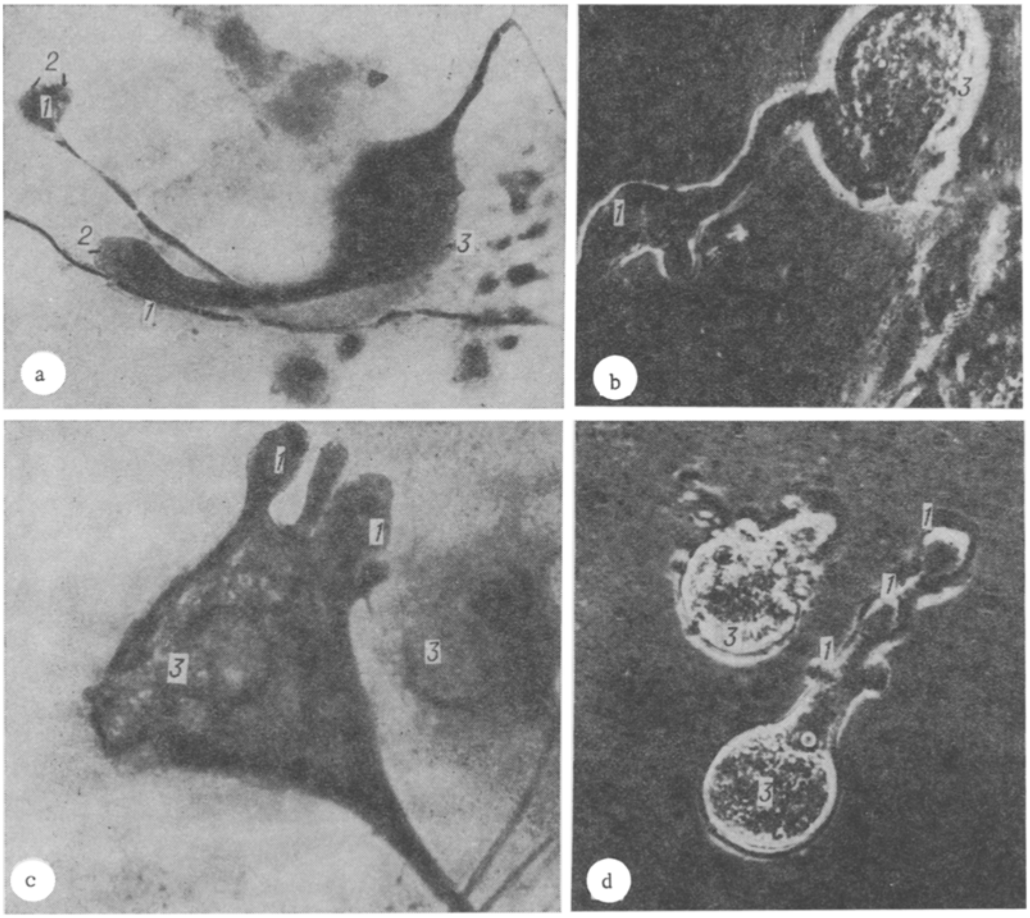

Fig. 1. Patterns of retraction of processes of nerve cells in intestine (a, b) and isolated neurons (c, d). 1) Retraction bulbs, 2) translucent peripheral zone of neuroplasm, 3) neuron body. a, b) Impregnation of total preparation of intestine by Gomori's method; c, d) intravital phase-contrast microscopy 400×.

Histological preparations were compared with structural processes observed in living neurons with a preserved system of dendritic branches, isolated from ganglia of the mollusk *Clione limacina* by the method described previously [9]. Data of short-term culture of isolated molluscan neurons [8] also were used for comparison.

EXPERIMENTAL RESULTS

Overflows of neuroplasm discovered in the intestinal wall were located primarily on dendrites (Fig. 1). However, by no means were all the dendrites modified. Their structural changes frequently exhibited polarity, i.e., a group of dendrites was changed only at one pole of the cell, whereas the similar processes in other parts of the neuron showed no change. Deformed dendrites were greatly widened and had club-shaped expansions at their ends (Fig. 1a). Sometimes they appeared to be very short and to have no branches. Heterogeneity of the cytoplasmic material could be observed in these neuron processes, and it possessed metallophilia. A narrow layer of looser (translucent) peripheral neuroplasm and a dense central portion with increased affinity for lead can be seen in all four modified dendrites in Fig. 1b. This picture can perhaps be explained not only by exhaustion of the peripheral zones, but also by a lower concentration of dry substances there. Similar segregation of the neuroplasm has often been observed in other parts of the neuron during reactive changes in its structure [9].

Comparison of these observations with the time course of dendritic structure observed in living isolated neurons (Fig. 1c) and also in nerve tissue culture shows surprising similarity between them. Preparations of so-called neuroplasm pools were completely indistinguishable from the patterns observed during retraction of the dendrites. Equally greatly widened, straightened short processes with thickenings at their ends were observed in the

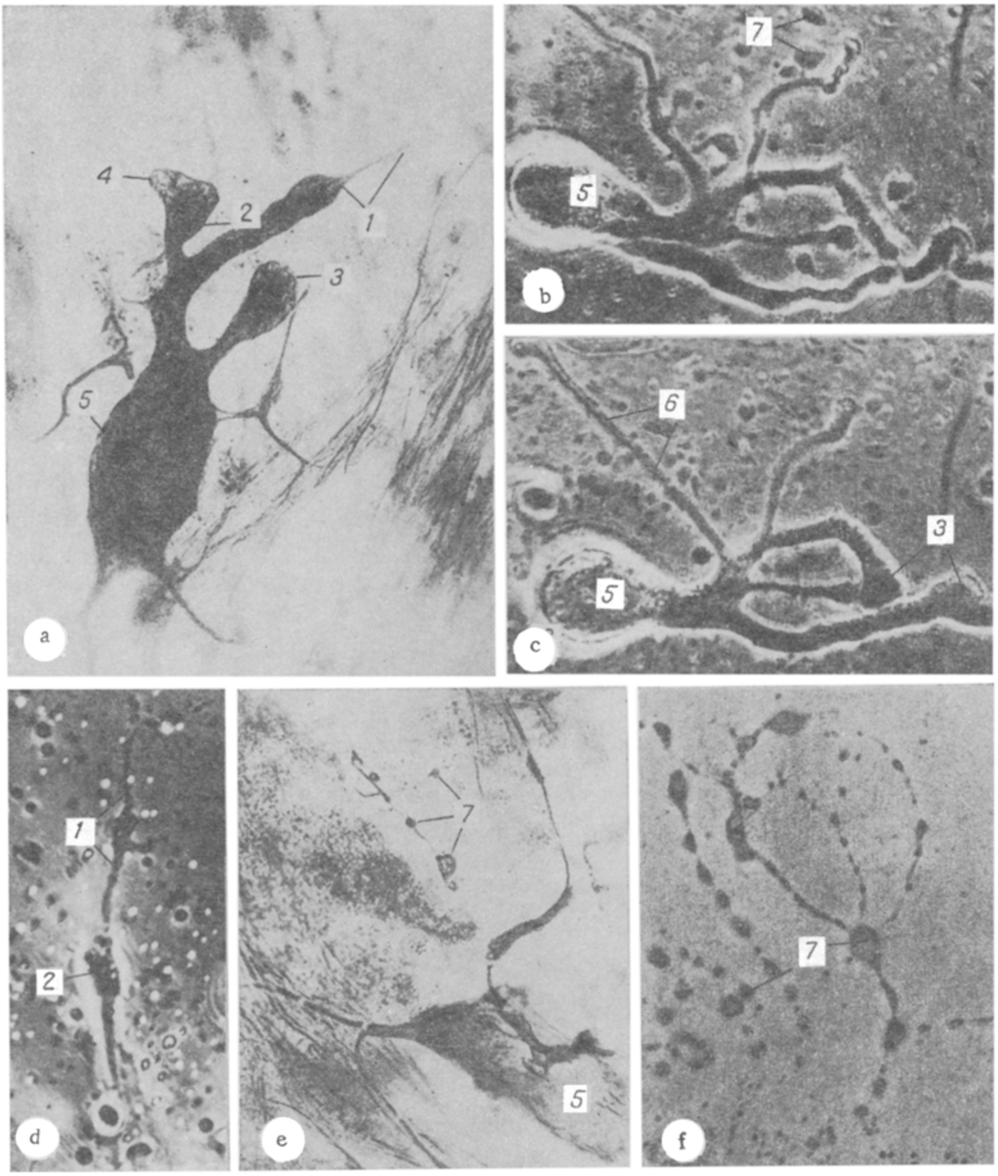

Fig. 2. Extrusion, retraction, and self-amputation of dendrites: a, d) phenomenon of extrusion (1) and retraction (2) on dendrites of the same neuron; b, c) straightening and thickening of processes during retraction; e, f) self-amputation (7) of dendrites, 3) retraction bulbs, 4) translucent peripheral zone of neuroplasm, 5) neuron body, 6) straightening of stretched process. a, d) Impregnation of total preparation of intestine by Gomori's method; b, c, d, f) intravital phase-contrast microscopy. 400×.

latter. This comparison is fundamental because it shows that static histologic pictures reflect, not an "overflow," nor a proximal-distal flow of neuroplasm but, on the contrary, retrograde movement of the neuroplasm and retraction of the whole dendrite. This conclusion can be verified by several features which are morphological equivalents of the process of dendrite retraction in nerve tissue culture and in isolated cells with a preserved system of dendrites. Cones of growth of nerve fibers are shaped like a triangular plate with several mobile projections of filopodia. At the beginning of reactive retraction the cone of growth is converted into a club-shaped structure at the end of the process (Fig. 1d), which has often been described as the "globe" phenomenon and by other names. Club-shaped structures, like lamellar structures, are frequently called cones of growth. However, intravital observations show that these are clubs of retraction and not of growth. The presence of club-shaped terminal structures in histological preparations is undoubtedly a sign of retractile processes.

A result of retraction of living dendrites is frequently the appearance of partial self-amputation of dendrites (Fig. 2). The considerable force of contraction of the dendrites is opposed to the powerful adhesion of their multiple branches to the substrate. The mechanical strength of the thin terminal fibrils is often weaker than the force of adhesion, and in that case the fibrils break. Amputated fragments of plaque, twigs, and whole tufts are preserved for some time in tissue culture around club-shaped proximal stumps of contracted twigs (Fig. 2). Consequently, pictures of amputated fragments of dendrites may also be morphological equivalents of retraction processes in the dendrite system.

Analysis of histologic preparations of the intramural nervous system in the present experiments showed that the appearance of overflows of neuroplasm is always accompanied by the formation of many club-shaped structures on the ends of the dendrites (Fig. 1) and by self-amputation of fragments of preterminal branches. Zones of thinning and regions of breaking of dendrites, amputated fragments, and retractile club-shaped thickenings can be seen in Fig. 2d, e. In histologic preparations a third sign of an approaching picture of fixed preparations with a reactive trend of the structure of the living dendrites also can be seen. The process of dendrite retraction does not take place steadily, but in waves. Contraction of the dendrite periodically stops and is replaced by a short-term process of extrusion of a new, thin, sharply pointed process (an attempt at regeneration). Similar thin, sharp-pointed outgrowths also are found on retracting dendrites of fixed neurons.

These data are evidence that the so-called overflows of neuroplasm are a reflection not of proximal-distal movement of the neuroplasm, but of reactive retraction of the nervous processes.

The problem of cellular mobility arouses increasing interest because actin- and myosin-like contractile proteins are found in virtually all cells, including nerve cells, and contractile effects have been described in many processes in cell physiology [1, 11-13].

The investigations show that a high degree of mobility also is characteristic of dendrites; it is observed, moreover, not only in isolated neurons (*in vitro*), and not only in invertebrates, but also in organs (*in situ*) of higher vertebrates. Retractile changes in dendrites are reactive in character, for they are enhanced in the presence of unfavorable external influences. However, the fact that the retraction phenomena described above may be observed in the autonomic nervous system and also in control animals is evidence of the high reactive mobility (variability) of intramural neurons under normal conditions.

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