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Short Communication

Somatic Growth, Tissue Streaming and Sexual Maturation: Polemic Overview on Their Hormone-Dependent Interrelationship in Ontogeny

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Abstract

An overview is presented mainly on our own studies, as referred to evaluation of hormone-dependent somatic growth in relation to tissue streaming and sexual maturation in pre- and postnatal ontogeny. It is suggested that especially the alterations of tissue streaming in aging should be studied in near future with much higher rigor than previously.

Key words: body growth; tissue streaming; sexual maturation; ontogeny

Introduction

We shall begin this article with some definitions. In auxology somatic and organ growth is usually defined simply as an increase in their linear dimensions, as well as in their volume and weight (or mass). On the other hand, tissue streaming is defined as an ordered translocation of cells or cell layers from cambial layer of stem cells to the layer of terminally differentiated cells with their subsequent elimination, in the following sequence [1]:

$$SC \rightarrow PC \rightarrow <DC \rightarrow >DC \rightarrow A / R,$$

where SC – stem cell, PC- progenitor cell, <DC – less differentiated cell, >DC – more differentiated cell, A / R – apoptosis / removal.

Historically, Gershom Zajicek in Israel was the first to study tissue streaming in some organs (principally liver) of adult animals, during the eighties of the last century (see discussion in [2, 3]), whereas later on we used this paradigm in formulating the schemes of cytodifferones in anterior pituitary and adrenal cortex [4, 5]. Just recently we have made two attempts to amplify this paradigm: 1) by adjusting it to respiratory system [2]; 2) when proposing a combined concept of tissue streaming and endocrine regulation in homeodynamic (or homeokinetic) mode, i.e. with the use of ultradian biorhythms of episodic or pulsatile hormonal secretion [3].

Finally, sexual maturation is a complex process that begins with sexual differentiation of hypothalamic brain region in prenatal period, but here we shall focus our attention mainly on pubertal phase of postnatal ontogeny, together with pubertal growth spurt. Since our articles are widely accessible, being largely published in open access journals and in addition, mirrored on ResearchGate and Academia websites, we shall cite them here preferably, addressing the interested readers to their content for references to investigations of many other authors.

Ontogenetic Alterations Related to Somatic Growth, Tissue Streaming and Sexual Maturation

At first, we ought to explain, what is the difference between somatic growth and tissue streaming. This difference is clearly observed in adult state when somatic growth is terminated, but tissue streaming continues. What about other stages of ontogeny?

It appears that tissue streaming begins at the stage of histo- and organogenesis that in humans takes place in the 1st trimester of pregnancy and should be related also to maturation of immune mechanisms not directed in this case against microorganisms but serving for elimination of apoptotic and terminally differentiated cells at the ends of cytodifferones (see the scheme presented in Introduction). From this stage and subsequently, body and organ growth is probably combined with tissue streaming, but what exactly determines the difference between these two processes, resulting in a net increase in linear dimensions, as well as in the volume and weight of the body and organs, unfortunately remains not understood till the present moment.

Earlier we have studied somatic growth in humans and on experimental models in rats since 1994, i.e. for more than 30 years. Especially important was our original approach for linearization of conventional growth curves in mono- and bilogarithmic coordinates [6]. This approach allowed us to reveal at least two ontogenetic transitions, juvenile and pubertal one, thus separating the whole postnatal ontogeny to 3 stages that in rats roughly coincide with 3 periods having different mechanisms of somatic growth, as referred to hyperplasia, hypertrophy and their combination.

It is essential to outline that theoretical analysis of these mechanisms was performed in the past only on the basis of biochemical evaluation of DNA and total protein, without considering heterogeneous nature of various tissues that contain several cytodifferones. In humans one more ontogenetic transition was identified, i.e. infantile one that in rats may coincide probably with juvenile transition, on the basis of weaning, together with terminated lactation in both species. The next question, therefore, would be the following: how ontogenetic transitions identified as breaks of straight lines on linearized growth plots are related to probable changes in tissue streaming? Here the author would like to outline that this article aims at formulating some questions that still don't have clear responses.

Let's focus our attention now on pubertal phase of postnatal ontogeny. It is already well known that the growth of reproductive organs (and first of all, uterus in females and prostate in males) is tightly regulated by sex steroid hormones, mainly by estrogens in females and androgens in males, that in turn are dependent principally on pituitary gonadotropins. To our surprise, the inhibitory action of glucocorticoids (GC) on sex steroid- and gonadotropin-induced growth of reproductive organs in both sexes was less expressive than GC effects on somatic (or body) growth [7]. On the other hand, only in neonatal period GC were able to cause irreversible (or partially reversible) inhibition of somatic growth [8]. On the basis of this peculiarity, we proposed to consider infantile ontogenetic transition that separates pre- and perinatal development (the first 1000 days of life in humans since conception and till the age of approximately 2 years) from other part of postnatal ontogeny as the boundary for differentiating the programming / imprinting and embedding-like phenomena [9].

Therefore, the next question (also without clear response yet) would be the following: how tissue streaming is altered in reproductive and other organs during puberty and in perinatal period, especially under the influence of GC? Moreover, what governs the temporal sequence of reproductive organ growth in relation to pubertal spurt of somatic growth?

Final Remarks

For a long time, more or less beginning with identification of DNA structure in 1953, we could imagine that biochemistry and molecular biology were able to bring about the progress in biomedicine. However, although these sciences in fact, had incredibly great advances in describing macromolecules (nucleic acids, proteins, complex carbohydrates and lipids) in the cells, neverthelss, at the same time they failed to establish fine tissue and organ structures, simply because of the first step in biochemical procedures, i.e. homogeneization that transforms complex heterogeneous organs and tissues to homogeneous mixtures, thus with important loss of information about cytodifferones.

Therefore, less expressive advances in histology and micromorphomotery resulted in essential lack of our clear understanding of ontogenetic interrelationship between somatic growth, tissue streaming and sexual maturation, in relation to their hormonal regulation. What should be done in near future? First of all, financial support to histology and micromorphometry has to be greatly enhanced. Moreover, new perspective approaches must be elaborated, including three-dimensional (3D) reconstruction of tissue structures in real time, using modified ultrasound and other modern imaging technologies.

In this regard, much more attention should be attracted to growth proportionality. Earlier we studied this important aspect, unfortunately ignored by pediatricians till the present time, employing the protocol based on a system of acupuncture channels (meridians) and points, considering its uniqueness for investigating in parallel somatic growth in proportions both in humans and at least some animals of rather big size, such as dogs [10, 11]. We believe that continuation of these studies may be a starting stage for subsequent elucidation of the mechanisms of hormone-dependent somatic growth, tissue streaming and sexual maturation during pre- and postnatal ontogeny.

Earlier we have already outlined that especially important should be the evaluation of underlying mechanisms for much lower tissue streaming in aging, considering also the possible contribution to them of lower pulsatile secretion of hormonal bioregulators in the homeodynamic (or homeokinetic) mode [2, 3]. In conclusion, the clarification of complex interrelationship between hormone-dependent somatic growth, tissue streaming and sexual maturation has many immediate and long-term perspectives and therefore, should be supported by numerous theoretical and experimental investigations.

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