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Review Article

ENDOCRINOLOGY OF CALCIUM HOMEOSTASIS IN FISHES

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ABSTRACT - Though fish live in aquatic medium from freshwater to environments of varying Ca concentrations, their plasma Ca level is precisely regulated. They possess well-developed ultimobranchial gland (UBG) and corpuscles of Stannius (CS) as well as 25-hydroxyvitamin-D-1α-hydroxylase in their renal tissue. UBG secretes calcitonin (CT) while CS elaborates two forms of stannicalcins - STC1 and SCTC2. The latter is widely distributed in various organs in the phylogeny and its level increases among women with breast cancer. Recently, four stanniocalcin genes have been isolated from CS of teleost and their physiological and phyogetic significance are being studied. Fish do have capacity to metabolize vitamin D with the receptor (VDR) widely distributed in various organs including intestine, gill and kidney. Though fish lack functional parathyroid glands (PTG) found in tetrapods, PTH-like immunoreactivity has been identified in hypothalamus, pituitary and CS. Parathyroid hormone-related peptide (PTHrP) has also been found in elasmobranch and teleosts but its role in normal piscine Ca metabolism has not yet been defined. Recent advances in endocrine regulation of Ca metabolism in fish has been discussed.

Key words : Ultimobranchial gland, calcitonin, Stannius corpuscles, stanniocalcins, Vitamin D, prolactin, somatolactin, Ca homeostasis, fishes.

INTRODUCTION

Placed on the lower rungs of vertebrate hierarchy, fishes offer a special opportunity to study the various endocrine glands involved in calcium (Ca) regulation. The regulation of Ca is a vital feature of all fishes inhabiting extremely varying aquatic conditions. The concentration of Ca^{2+} in plasma of fish is regulated with great precision despite the wide fluctuations in the intake and excretion of Ca. The main Ca regulating endocrine glands are - pituitary, vitamin D-metabolizing system, ultimobranchial glands (UBG) and corpuscles of Stannius (CS). Comparative endocrinology of Ca regulation is very interesting because it provides a most important clue in the mystery of the evolution of the vertebrates (Urist, 1966). Also, the regulatory systems for Ca are very different among vertebrates adapted to different mode of life (Pang and Yee, 1980; Pang *et al*, 1980a, b; Taylor, 1985; Pang and Schreibman, 1989; Pandey, 1991, 1992). Fishes live in the aquatic environment of varying salinity which serves as an inexhaustible reservoir of Ca for them. Even in soft water where the external Ca level is extremely low (0.01-0.40 mM), fish actively extract (transport) this cation from the medium either through integument of the gills, chloride cells, gut, bone or scales (Wendelaar Bonga *et al*, 1983; Ichii and Mugiya, 1983; Ishihara and Mugiya, 1987; Mugiya, 1990; Sundell and Björnsson, 1990; Flik and Rentier-Delrue, 1991), however, gill appears to play major role in hydromineral balance of fishes (Milhaud *et al*, 1977, 1980; Flik *et al*, 1985a, b; Flik and Perry, 1989).

The cyclostomes, chimaeroids and elasmobranchs have only cartilaginous skeleton while many bony fishes have acellular bone which is incapable of remodelling (Copp, 1969). The hagfish maintains serum Ca about half that of SW while the lamprey has concentration almost the same as that of man. These cyclostomes lack all the three important factors present in terrestrial vertebrates (bone, parathyroid and UBG) and apparently regulate body Ca in an open system through controlled transfer across gill membranes (Urist, 1962). The chimaeroids and elasmobranchs also contain no true bones and presumably control Ca through membrane mechanisms (Urist, 1966). However, the UBG first appeared in these fishes and contain calcitonin (Copp *et al*, 1967) which in higher vertebrates control hypercalcemia. Calcitonin can hardly act on bone resorption since there is none but it may possibly facilitate appropriate Ca transport mechanisms and so participates in Ca regulation. This would also apply to teleosts with acellular bones (Copp, 1969).

Though the problem of Ca regulation in submammalian vertebrates has been discussed (Urist, 1976; Dacke, 1979; Oguro and Uchiyama, 1980; Pang *et al*, 1980a; Barlet,1982; Feinblatt, 1982; Clark, 1983;