

EXPLORING THE ANATOMY AND PHYSIOLOGY OF AGEING

PART 7 – THE ENDOCRINE SYSTEM

AUTHORS John Knight, PhD, BSc; Yamni Nigam, PhD, MSc, BSc; both lecturers in biomedical science, School of Health Science, Swansea University.

THE PITUITARY GLAND

The pituitary, often referred to as the master gland, regulates the activity of many of the major endocrine organs. It is split into a posterior portion, which is an extension of the hypothalamus, and an anterior portion which is formed from epithelial cells.

Growth hormone and the somatopause

Somatotropin (growth hormone) is secreted by the anterior pituitary. In early childhood somatotropin is released at relatively low concentrations but during the teenage years there is a marked increase in serum levels corresponding to the growth spurts characteristic of puberty. In the mid-20s and beyond, somatotropin release gradually decreases until in old age, serum levels are low (Veldhuis et al, 2005). The decline in somatotropin secretion in later years, often referred to as the somatopause, is associated with a variety of clinically significant changes including:

- A general reduction in protein synthesis;
- A progressive reduction in lean body mass (muscle) that contributes to a reduction in the metabolic rate;
- Reduction in bone mass and density leading to increased likelihood of osteoporosis and fractures;
- A general decrease in immune function and increasing susceptibility to infection.

While the cause of the somatopause remains uncertain there is evidence that it can be hastened and exacerbated in those individuals who lead a sedentary lifestyle and carry a high percentage of body fat.

THE THYROID GLAND

The thyroid gland plays a major role in controlling metabolism and regulating blood calcium levels. Its secretions regulate a

multitude of physiological processes including the following:

- Metabolism of carbohydrates, fats and proteins;
- Thermoregulation;
- Digestion;
- Muscle and nerve activity;
- Maintaining normal bone density.

T3 and T4 and the metabolic rate

Cellular metabolism is largely under the control of the iodine-containing hormones T4 (thyroxine) and T3 (triiodothyronine).

The clearance of T4 by the liver decreases with age but this is offset by a gradual decline in its secretion by the thyroid, so serum levels tend to remain relatively constant.

However, an age-related decrease in the serum T3 concentration (Chahal and Drake, 2007) may contribute to the gradual reduction in basal metabolism that is apparent in middle and old age.

Autoimmune reactions against the thyroid gland are commonly seen with advancing age, indeed the presence of antibodies specific to thyroid tissue in older people is so common that it is often considered a normal age-related change. Their presence at high concentration may herald the onset of autoimmune hypothyroidism, a disease common in older people and associated with low metabolic rates, a tendency to put on weight and low core temperature.

Changes to parathyroid function

Parathyroid hormone (PTH) is usually released following a decrease in blood calcium levels. It triggers the release of calcium from bone by stimulating the bone-digesting cells termed osteoclasts. Several studies have revealed an age-related increase in the level of circulating PTH (Portale et al, 1997).

It has been suggested that this, together with the decrease in plasma somatotropin, are major factors contributing to the reduction in bone density often seen in middle and old age.

CHANGES IN PANCREATIC FUNCTION

The endocrine regions of the pancreas (the islets of Langerhans) regulate blood glucose levels. Within the pancreatic islets the beta cells secrete insulin in response to increased blood glucose (typically following a carbohydrate-rich meal). Insulin binds to receptors present on most cells triggering cellular uptake of glucose from the blood. Once inside cells, glucose can be used immediately to release energy, or converted into glycogen or fat for storage.

With advancing age cells become progressively less sensitive to the effects of insulin. The most likely cause of this appears to be a reduction in the number of insulin receptors on the surface of cell membranes. This reduction in insulin sensitivity is reflected by a gradual increase in blood glucose concentrations.

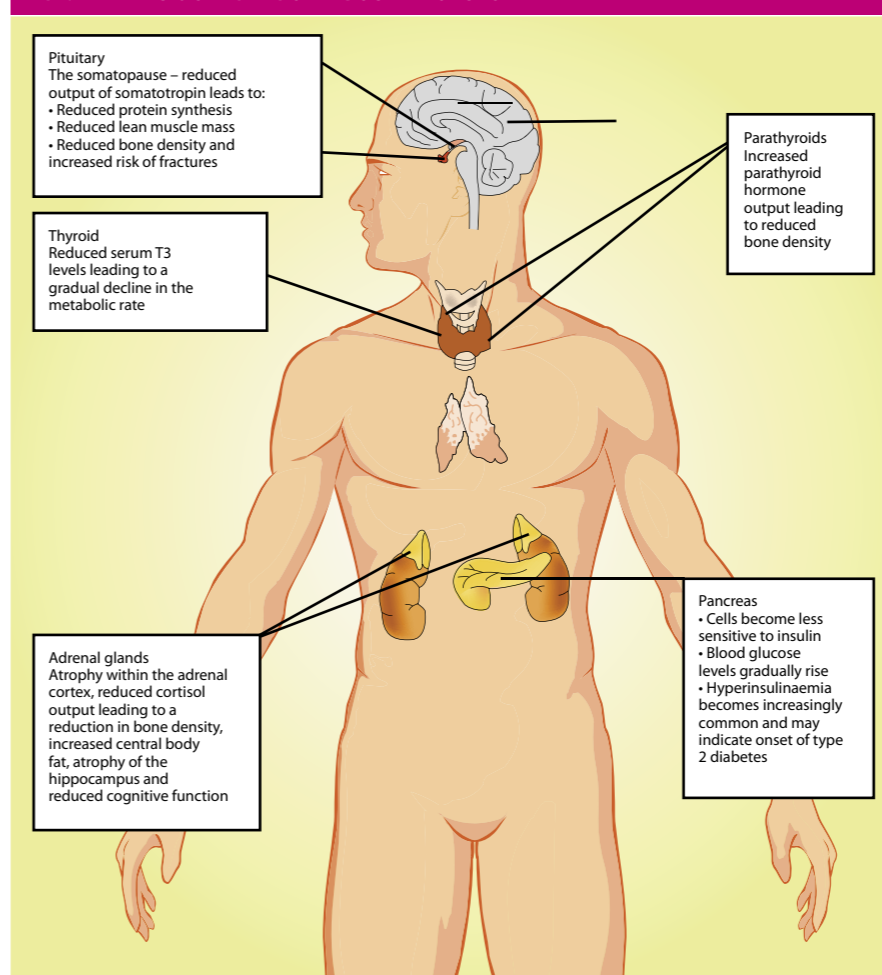
It has been estimated that fasting blood glucose levels rise 1–2mg/dl for each decade after age 30 (Anderson and Cockayne, 2002). Whether this rise represents a normal age-related change or the early stages of diabetes is unclear but it is present in many older people with no other symptoms of diabetes.

With advancing age the sensitivity of the beta cells to elevated glucose decreases and a much higher blood glucose concentration is required to trigger insulin release. Since the cells in older people are less sensitive to insulin, the pancreas may respond by producing more insulin leading to hyperinsulinaemia; this often correlates with the emergence of type 2 diabetes.

CHANGES TO ADRENAL FUNCTION

The adrenal glands are located above the kidneys; each consists of two major regions. The adrenal medulla secretes the catecholamines adrenaline (epinephrine)

FIG 1. THE EFFECTS OF AGEING ON ENDOCRINE FUNCTION



and noradrenaline (norepinephrine). These are the classic fight or flight hormones that prepare the body for activity when threatened or in a state of excitement. There is evidence that their levels increase with age but this appears to be offset by a reduced sensitivity to their effects (Grossman et al, 1998).

The adrenal cortex synthesises and secretes a variety of steroidal hormones including the following:

Aldosterone: This regulates plasma levels of sodium and potassium and plays an important role in water balance. Research has revealed an age-related decrease in serum aldosterone levels, effectively reducing the body's ability to retain sodium. Since sodium attracts water into the

cardiovascular system by osmosis, reductions in the plasma sodium levels can reduce blood volume and blood pressure. It has been speculated that reductions in adosterone secretion may contribute to the postural hypotension and lightheadedness that is often experienced by older people. This is supported by research demonstrating significant reductions in serum aldosterone when individuals are upright as opposed to recumbent (Hegstad et al, 1983).

Cortisol: This stress hormone is released from the adrenal cortex following biological stressors such as physical injury or starvation. It is a natural anti-inflammatory molecule and also plays a very important role in the breakdown of protein and fat. Research has revealed a 20–50% increase in mean levels of cortisol secretion between the ages of 20 and 80 (Chahal and Drake, 2007).

There appears to be a strong link between

the increased cortisol levels of old age and reductions in bone density. Research has indicated elevated cortisol levels correspond with an increased risk of bone fractures in both older men and women.

There is also growing evidence that the gradual increase in circulating cortisol concentrations contributes to loss of cells from the hippocampus (Chahal and Drake, 2007). This leads to hippocampal atrophy, which is often associated with a reduction in cognitive abilities in older people. Other studies have shown that changes in cortisol levels may also be linked to memory loss and interrupted sleep patterns.

It appears that little can be done to ward off most of the age-related changes that occur in the endocrine system, so nurses will routinely encounter the consequences of this process, particularly the reduction in bone density experienced in older people.

There is some evidence that exercising regularly and maintaining a low percentage of body fat may slow the onset of the somatopause and improve the control of blood glucose. n

REFERENCES

Anderson, S.C., Cockayne, S. (2002) *Clinical Chemistry: Concepts and Applications*. New York, NY: McGraw-Hill Medical.

Chahal, H.S., Drake W.M. (2007) The endocrine system and ageing. *The Journal of Pathology*; 211: 173–180.

Grossman, A.E. et al (1998) *Clinical Endocrinology*. Oxford: Wiley-Blackwell.

Hegstad, R. et al (1983) Ageing and aldosterone. *American Journal of Medicine*; 74: 3, 442–448.

Portale, A.A. et al (1997) Ageing alters calcium regulation of serum concentration of parathyroid hormone in healthy men. *American Journal of Physiology – Endocrinology and Metabolism*; 272: 139–146.

Veldhuis, J.D. et al (2005) Joint mechanisms of impaired growth-hormone pulse renewal in ageing men. *Journal of Clinical Endocrinology and Metabolism*; 9: 7; 4177–4183.

NT For more Systems of Life log on to nursingtimes.net and click on NT Clinical and Archive

Catherine Hollick

NEXT WEEK
The physiology of ageing:
part 8 – the reproductive system