The Ultrastructure of the Parathyroid Gland in Cadaveric Embalmed Specimens

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ABSTRACT

Objective: This study is to observe ultrastructurally of the parathyroid gland from cadaveric embalmed specimens by light microscopy and by transmission electron microscopy.

Methods: The parathyroid glands were carefully dissected from the posterior surface of thyroid glands of the cadavers of the Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University. Each parathyroid was bisected into two, one put into 10% formaldehyde and the other to the 2.5% glutaraldehyde. The first group was prepared for routinely HE staining for light microscopy. The one which the specimen with the best preserved was chosen to prepare for the TEM.

Results: The parathyroids of the cadavers were all well preserved as viewed by light microscopy. They are all reviewed the chief and oxyphil cells which easily distinguishable. The chief cells are more numerous and acquired the characters of actively synthesis of materials. These are the basophilic cytoplasm and large clear nucleus. The oxyphil cells are less numerous and acquired its characters of larger cells, red cytoplasm and dense dark nuclei. When viewed by TEM, it is cleared that the cells are well preserved. The chief cells are characterized by large heterochromatic nucleus and the cytoplasm is filled with the secretory vesicles, some of which the RER and the Golgi apparatus can be observed.

Conclusion: The human tissue from the cadavers of the Department of Anatomy, Faculty of Medicine Siriraj Hospital was well preserved even viewed by TEM. This may be due to the fact that the fixative was pushed through the great vessels until it circulated throughout the blood vessels of the whole body. Especially the endocrine glands such as the parathyroids which were richen in blood supplies, the fixative might be forced through the capillary sinusoid and then this tissue is highly preservation.

Keywords: Parathyroid; TEM

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The parathyroid glands are small oval endocrine glands closely associated with the thyroid gland. In mammals there are usually two pairs of glands, one pair situated on the posterior surface of the thyroid gland on each side. The embryological origins of the parathyroid glands are the third and fourth branchial pouches. The parathyroid glands regulate serum calcium and phosphate levels via the parathyroid hormone (parathormone). This hormone raises serum calcium levels in three ways, firstly is the direct action on bone, secondly is the direct action on the kidney and thirdly is the promotion of the absorption of calcium from the small intestine. Secretion of parathyroid hormone is stimulated by a decrease in blood calcium levels. In conjunction with calcitonin secreted by the parafollicular cells of the thyroid gland. Parathyroid hormone is the most important regulator of blood calcium levels and is essential to life whereas calcitonin appears to provide a complementary mechanism for fine adjustment and is not essential to life. The hormone acts upon osteocytes, causing them to mobilize bone mineral from the matrix immediately around them, a process called osteocytic osteolysis. If this does not quickly correct the low blood calcium level, the osteocytes release a cytokine that causes coalescence of precursor cells to form increased numbers of osteoclasts, which erode bone and thus release its calcium. This process, called osteoclastic osteolysis, is slower, taking many hours to reach effective levels of calcium release[1-3].

Fresh human specimen of the parathyroid gland is very difficult to obtain as it adheres the posterior surface of the thyroid where the exact positions are varied so the dissection for the gland consumes time. In this study we try to dissect the parathyroid glands from the cadaveric embalm specimens used for gross anatomy. We carefully fixed the glands one by one and observed by light

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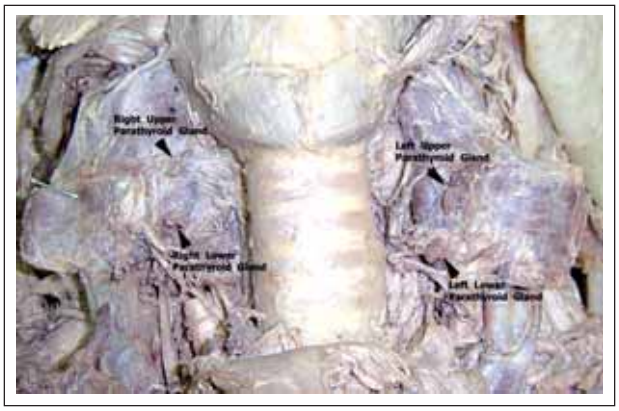

Fig 1. The parathyroid glands (arrow head) at the posterior surface of the thyroid gland.

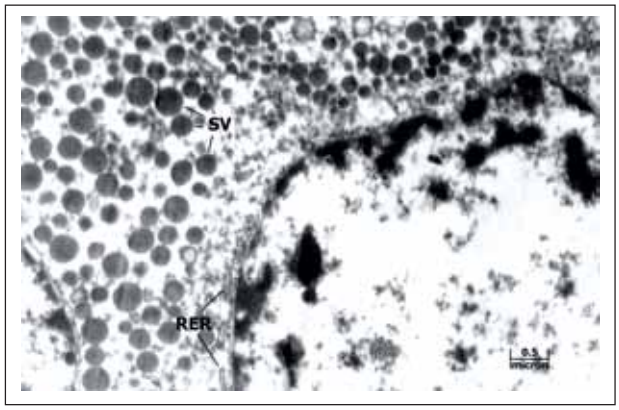

Fig 3. The TEM micrograph of the chief cell which cytoplasm comprises densely pack secretory vesicles (sv).

microscopy from the routine HE staining histological slide. The highly preserved specimens were further studied by transmission electron microscopy.

MATERIALS AND METHODS

Twenty parathyroid glands were carefully dissected from the posterior surface of the thyroid glands of the cadavers of the Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok. These cadavers were routinely preserved by the preservative formula of the Department, include formalin and phenol mixture injected by slightly pumping force through the femoral artery in an excess volume. The cadavers were then kept by soaked in the fixative for 1 or 2 years before bringing to the gross anatomy dissecting room. In the region of the head and neck, we removed the parathyroid glands and bisect each to fix into two fixatives. The correspond glands of both halves were given the same number but fixed in firstly 10% formaldehyde and the other half in 2.5% glutaraldehyde. The first half is to prepare for the routinely HE staining for light microscopy. The second half is to prepare for the routinely transmission electron microscopy. The first half is observed under light microscopy before further observation by transmission electron microscopy. The best preservation of parathyroid glands under LM were all observed under TEM.

RESULTS

Twenty parathyroid glands from cadaveric embalm specimens were studied under light microscopy. (Fig 1) The photograph shows the tracheal rings with the thyroid gland bisected and elevated laterally to show the posterior surfaces. The four parathyroid glands were dissected out from the capsule of the thyroid gland. (Fig 2) The micrograph of the parathyroid glands under light microscopy. The thin fibrous capsule gives rise to delicate septa which divide the parenchyma into dense cord like masses of secretory cells. The septa carry blood vessels, lymphatics and nerves. The parathyroid gland contains secretory cells of two types : chief (principal) cells and oxyphil cells. The chief cells are the most abundant cells and are responsible for the secretion of parathyroid hormone. Chief cells have a prominent nucleus and relatively little cytoplasm which varies in staining intensity according to the degree of secretory activity of the cell. The oxyphil cells are larger and much less numerous than chief cells and tend to occur in clumps. They have smaller densely stained nuclei and strongly eosinophilic cytoplasm containing fine granules. Few oxyphil cells are found in human parathyroid gland until puberty after which they increase in number with age. Oxyphil cells do not secrete hormones except in certain pathological conditions.

These transmission electron micrographs show the chief cells differ according to the level of their activity. Active chief cells have large nucleus with typically bilayer nuclear membrane. The nuclear chromatin is dispersed, showing the mostly electron-lucent area, the euchromatin which represent the part of the DNA which active in RNA synthesis. The nuclei of the chief cells illustrate in Fig 3 and 4 are typical nuclei of a highly active, protein secreting cell, in this case the parathyroid hormone containing polypeptide chain. The cytoplasm comprises secretory

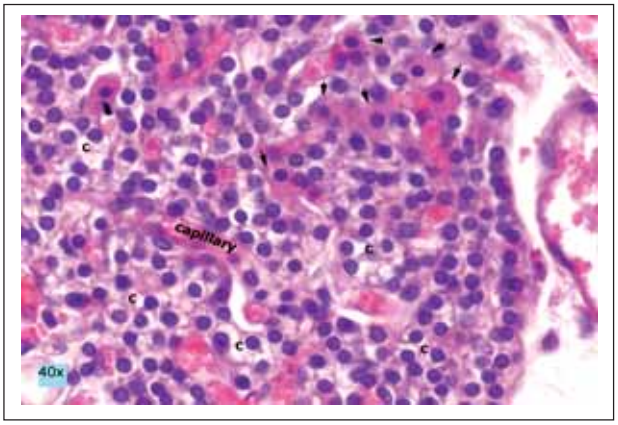

Fig 2. The parathyroid gland under light microscopy (obj 40 x) The gland contains chief cells (c) and oxyphil cells (arrow head).

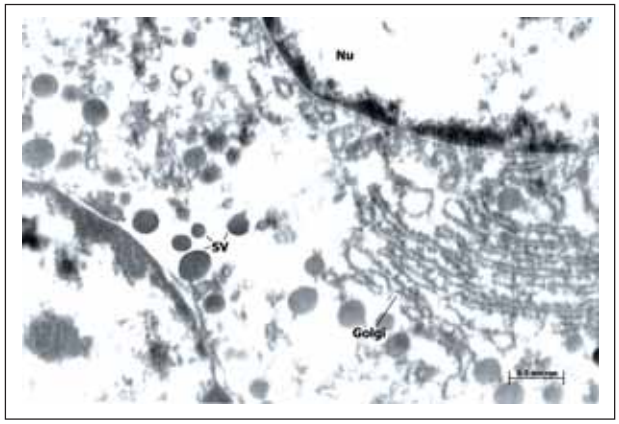

Fig 4. The TEM micrograph of the chief cell which less dense secretory vesicles (sv) and large stag of the Golgi apparatus.

vesicles which were electron dense vesicles of vary diameter about 200-400 nm. and dispersed throughout the cytoplasm. The RER appears close to the nuclear membrane while the peripheral zone may be obscured by the densely pack secretory vesicles (Fig 3). In another less dense secretory vesicle (Fig 4) the RER and large stag of the Golgi apparatus are observed and are situated close to the nuclear membrane.

DISCUSSION

The parathyroid glands from the cadavers were observed under light and transmission electron microscopy and compared the morphology of the cells and organelles with the typical cells and organelles from the standard textbook[1-5]. This study revealed that in the light and transmission electron microscopy, the cells and organelles are well preserved. In LM we can see that the chief cells and oxyphil cells are absolutely typical without the area of cell damages or lysis. The chief cells comprise of large round and vesicular nuclei with relatively little cytoplasm which varies in staining intensity according to the degree of secretory activity of the cell. The oxyphil cells are larger and much less numerous than the chief cells. They have smaller densely stained nuclei and strong eosinophilic cytoplasm. The glands also show highly vascularization with the sinusiodal capillaries infiltrate throughout small group of cells. These characters are typical morphology of the parathyroid gland.

The transmission electron micrographs also revealed the cell of highly preservation as we can see the large euchromatic nuclei with disperse chromatin granule, the RER and the Golgi apparatus. The typical secretory granules of vary diameter are very distinct.

Preserved procedures of the cadavers have to be very essential for the good appearance morphology of the cells and tissues even view by transmission electron microscopy. This may be the fact that the fixatives are forced through the large blood vessel in an excess quantity and as soon as possible. The procedure can be compared to the perfusion of the laboratory animals which is the best way in preserving the cells and tissues. Another important reason is that the nature of the parathyroid gland which is an endocrine gland locates superficially outside the cranium or vertebrae and is highly vascularization with the sinusoidal capillaries infiltrate throughout the whole organ. The fixatives are forced the blood vessel and reach the gland easily. This is also a good question for the endocrine gland which situates in the cranium, the pituitary gland, that is it well preserve as the parathyroid gland? Several human tissues are very difficult to get freshly, because of its location. Some tissue from the fresh cadaver can be used to prepare the histological slide for the medical student for the study of normal tissue, but may be not all. The study of the cadaveric embalmed tissue may be of an important in the future.

CONCLUSION

The parathyroid glands from the cadavers are well preserved viewed by light and electron microscopy. LM shows the typical chief cells and oxyphil cells without the area of tissue lysis. The electron microscopy also shows the actively synthesizing cells with large euchromatic nucleus. The secretory vesicle are distinct and numerous and may obscure some other organelles. Although the RER and the golgi apparatus can be observed near the nuclear membrane. This study shows the possibility of using some cadaveric tissues to prepare the histological slide. But further study should be done on other tissues so as to make sure whether the intracranium or intravertebral tissue or nonendocrine tissue which the blood supply is less numerous are also good preserved like the parathyroid glands.

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