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Estimation of Parenchymal Cell Mass of Parathyroid Glands using a Volumeter Technique

Göran Åkerström[1], Lars Grimelius[2], Conny Fridh[3] and Henry Johansson[1]

From the Departments of Surgery[1] and Pathology[2], University Hospital, Uppsala and the Institute of Technology[3], Stockholm, Sweden

ABSTRACT

A volumeter technique was used to estimate the density of the two main tissue components of the parathyroid gland - parenchymal and fat tissue. The difference in density between the two components was distinct (1.06 and 0.93 g/ml) and measurements of the weight and volume of parathyroid glands could therefore be utilized in calculating their parenchymal tissue content. The results of these measurements corresponded to those obtained at histopathological evaluation of parathyroid glands. The presented technique is simple and convenient and with slight improvement could be used for intraoperative characterization of parathyroid glands.

INTRODUCTION

Normal parathyroid glands contain parenchymal and fat cells and a minimal amount of stroma. The parenchymal cell mass probably best reflects the glandular endocrine activity. However, there are difficulties in estimating this cell mass, because of the irregular distribution of the parenchymal cells. Histopathological evaluation of the parenchymal cell content therefore has to be based on examination of a large number of sections. This is possible with an objective method using an image analysing computer technique (2) or semiquantitatively by conventional ocular evaluation. Both these methods have their limitations, however, in that the image analysing computer is not available in many centres and the ocular evaluation requires great experience on the part of the examiner. A more suitable method for determining the parenchymal cell content of parathyroid glands is therefore greatly needed.

As the two main glandular components, parenchymal and fat tissue, differ in density (according to the estimate of Gilmour and Martin (1) the respective densities are approximately 1.10 and 0.90 g/ml), it should be possible to use glandular density as an indirect measure of parenchymal cell content.

This report presents a method for density determination of parathyroid glands, using values of weight and volume. The volumes of the glands were

measured in a sensitive volumeter.

METHODS AND MATERIAL

A volumeter was constructed according to the diagram in Fig. 1. Phosphate-buffered saline (0.1 M, pH 7.2, 300 mOsm/l) was used as the fluid in the volumeter measurements. To represent the density of pure parenchymal cell tissue, pieces of histologically verified, fat-free, solid parathyroid adenomas were weighed and measured in the volumeter. The density of intraglandular fat tissue was calculated from measurements of small pieces of fat taken from the surroundings of the parathyroid glands. Volumes were determined as the mean of five

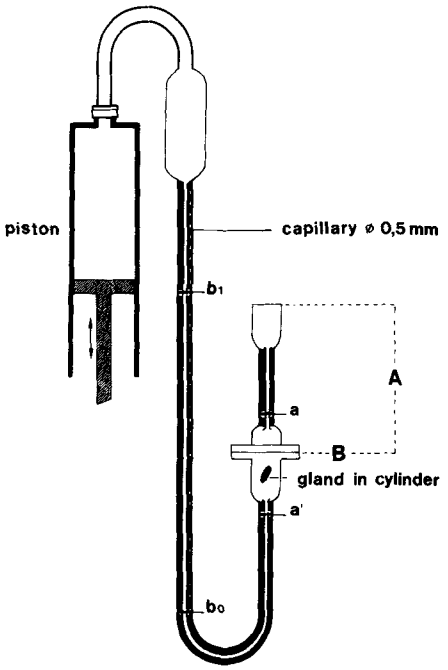

Fig. 1. Volumeter.
In measuring the volume of the gland Archimedes' principle is applied. Part A of the apparatus can be disconnected when the gland to be measured is put in the cylinder. Before disconnecting part A, the fluid is drawn below the cylinder (to a^1) with the piston in order to keep the fluid in the system. The connection B is a watertight, carefully ground glass-plate connection. When the gland is in the apparatus and the surface of the fluid is adjusted (to a), the other surface of the fluid column is moved from b_0 to b_1. The volume of the capillary from b_0 to b_1 is the volume of the gland.

consecutive measurements on the same piece of tissue. To prevent dehydration due to evaporation the pieces of tissue were kept in a moist chamber between measurements.

The reproducibility of the volumeter technique was evaluated and the maximal deviation from the mean value in series of repeated measurements was 1.23 %.

The volumeter technique was tested on ten parathyroid glands taken from autopsy cases within 24 hours after death. The glands were cleared of surrounding fat and weighed, and their volume was estimated in the volumeter. After these measurements they were fixed in formalin and stained with hematocylin-eosin, and the parenchymal cell content was evaluated by conventional light microscopy on 10-12 sections of each gland.

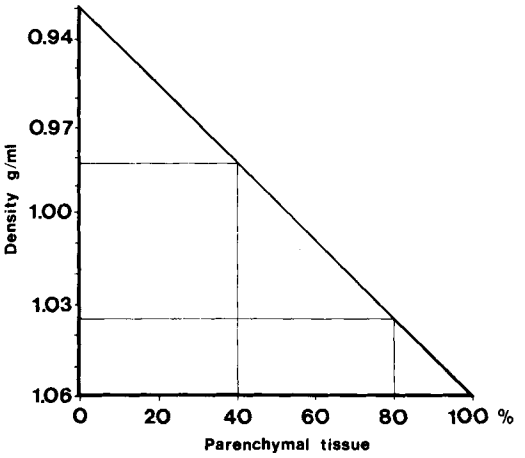

Fig. 2. Diagram relating density of parathyroid glands to parenchymal cell content.

The effects upon the measurement results of evaporation due to exposure to air between measurements were investigated.

RESULTS

The densities of parenchymal and fat tissue were found to be 1.059 ± 0.005 g/ml (n = 10) and 0.93 ± 0.02 g/ml (n = 10), respectively. From these results the diagram in Fig. 2 was constructed, to relate the density of glands to parenchymal cell content in per cent.

The results of these calculations of the parenchymal cell content were in agreement with the findings at light microscopy on 10-12 sections of each gland.

Water loss due to evaporation of tissue was found to have a marked effect upon the measurements. The total weight of glands exposed to the air for 15 min decreased by 10-15 % due to water loss. This water loss could be minimized by keeping the tissues in a moist chamber or covered with a piece of fat tissue between measurements.

DISCUSSION

In this study a volumeter technique was used to estimate the density of the two main tissue components of the parathyroid gland - parenchymal and fat tissue. The difference in density between them was pronounced (1.06 and 0.93 g/ml). From these values densities representing 100 % and 0 % parenchymal cell content were calculated and a diagram was constructed whereby glandular density could be used for estimation of the content of parenchymal cells. Values obtained by the use of this diagram were in agreement with parenchymal cell contents obtained by a conventional method, using light microscopy on 10-12 sections of each gland. The described technique is a new way of estimating the parenchymal cell mass of the parathyroids and is considered a useful advancement

in the histopathological characterization of these glands.

The reproducibility of the volumeter measurements was good. However, effects of tissue evaporation necessitated procedures to prevent water loss.

The volumeter technique is rapid compared to conventional histopathological methods for determination of the parathyroid parenchymal cell content. However, to get reproducible results measurements with the volumeter have to be made with great care, which makes them somewhat time-consuming. The method could be developed further, however, by electronic reading and automatic adjustments of the volumeter pistons. With such improvement it could well be of value for intraoperative characterization of parathyroid glands.

The density technique for histopathological evaluation of parathyroid glands has on basis of the preliminary results presented above now been further developed using a more convenient and reproducible density gradient column technique (3).

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Address for reprints:

Göran Åkerström, M.D.
Department of Surgery
University Hospital
S-750 14 Uppsala
Sweden