Islet Concentration in the Head, Body, Tail and Uncinate Process of the Pancreas

JERRY WITTINGEN AND CHARLES F. FREY, M.D.

From the Department of Surgery, Section of General Surgery, University of Michigan Medical Center, Ann Arbor, Michigan

ONE CONSIDERATION in planning operations for the traumatized or inflamed pancreas would be to preserve as many islets as possible. It has been stated that the concentration of islets is greater in the tail than in the head of the pancreas. We could find no documentation for this opinion in the medical literature.

Methods and Procedures

To determine the relative concentrations in various parts of the pancreas we divided it into four parts: 1) head, 2) body, 3) tail and 4) uncinate process. Pancreases were obtained from eleven autopsy cases, nine of whom had normal pancreases and one each with a history of diabetes mellitus and chronic pancreatitis.

Each pancreas was treated in the same manner. They were removed from the body during the post mortem examination, usually within 24 hours after death, and allowed to fix in formaldehyde for a day or two. The hospital registration number, age, sex, cause of death, associated diseases, and approximate body weight of each patient examined were recorded at the time of autopsy.

After fixing, each pancreas was first sectioned into the four main parts: head, body, tail and uncinate. Each part was weighed to the nearest gram and the total weight of the pancreas calculated. Each part was also measured in three dimensions to the nearest millimeter. The boundries which provided our guidelines for sectioning the gland into its respective parts were:

1. The right border of the superior mesenteric vein between the head and body.

2. The point at which the gland sharply narrowed between the body and tail.

3. The area underneath the superior mesenteric artery and vein was designated the uncinate.

Slices were taken at 1 cm intervals moving from right to left from each of the sections. Only one section was obtained from each uncinate because of its small size.

These slices were labeled and sent to the tissue lab where they were sliced, affixed to slides, stained with (H & E) and labeled. One slide was prepared from each of the slices sent to the lab. This procedure was identical to the method used to prepare other autopsy material.

Once the slides of pancreas tissue were ready, the islets were counted. The counting chamber was a small piece of formica with a hole drilled in it. The diameter of the hole was 6.0 mm and the *same* chamber was used for the entire project. The islets were counted at a magnification of 100×. If only a part of the islet appeared in the counting chamber it was counted as a whole islet if more than half of the islet was judged to be in the chamber. At least two different areas on each slide were counted.

Results

The number of islets from each slide was recorded as the average number counted per counting chamber area. This was done for each slide of each part of the pan-

Submitted for publication April 30, 1973.

Supported by the Medical Science Research and Education Fund, Wayne County General Hospital, Eloise, Michigan and The Section of General Surgery, University of Michigan Medical Center, Ann Arbor, Michigan.

TABLE 1. *Nine Normal Pancreases: Number of Islets Counted on a Circular Cross Section 6mm in Diameter*

Case No.	Sex	Age	Body Weight (lbs)	Pancreas Weight (gms)	Average Islet Concentration Head	Body	Tail	Uncinate
1	F	74	160	100	10.0	15.3	15.9	8.0
2	F	49	150	80	37.6	29.9	49.4	30.0
3	M	72	150	112	17.9	17.4	28.9	10.0
4	M	70	160	110	22.4	21.6	37.6	59.0
5	F	82	95	49	38.7	42.4	69.0	38.0
6	F	55	160	70	33.8	32.9	66.6	43.5
7	F	67	185	78	29.8	33.0	51.5	21.5
8	M	20	170	64	21.0	34.2	51.6	59.0
9	M	63	140	82	18.7	25.8	40.8	20.0

creas. Then for each part of the pancreas the average number of islets per counting chamber area for each part of the pancreases was calculated. These values are listed in Tables 1 and 2 for the normal and abnormal pancreases. The mean values of the number of islets per counting chamber area in the nine normal pancreases are listed in Table 3.

We found no consistent relationship between the islet concentrations of the pancreas or its parts to the patients age, sex, body weight or the weight of the pancreas. However, the concentration of islets was more dense in the tail of the pancreas when compared with the head or body of the gland.

Multivariate simultaneous confidence intervals for differences in means $[\mu^i - \mu_j$ with i = 1, 2, 3, 4 and j = 1, 2, 3, 4] yielded significant ($\alpha = 5\%$) for tail versus body and tail versus head. No other significant differences were noted.

A statement on the relative differences in the number of islets between the various parts of the pancreas may be made by comparing the mean value of each part with the overall mean. The overall mean being 32.578 islets per counting chamber.

$$\frac{\text{Head}}{\text{Overall}} = \frac{25.544}{32.578} = 0.784$$

$$\frac{\text{Body}}{\text{Overall}} = \frac{28.067}{32.578} = 0.862$$

$$\frac{\text{Tail}}{\text{Overall}} = \frac{45.700}{32.578} = 1.403$$

$$\frac{\text{Uncinate}}{\text{Overall}} = \frac{31.000}{32.578} = 0.952$$

According to the above calculations the tail appears to have considerably higher islet concentration than the rest of the gland.

Discussion

In none of the nine normals was the cause of death related to pancreatic pathology. The histological state of each of these pancreases was normal.

The pattern of islet concentration between head, body and tail of pancreases from patients with diabetes and pancreatitis appears to be the same as for the normals, but to reach a meaningful conclusion will require a larger patient sample.

A difficulty we encountered was determining the boundary between the body and tail of the gland. Since there was no satisfactory landmark available for this division, we tried to be consistent regarding the relative length of body and tail as well as the point where the pancreas narrowed down quite sharply.

The numbers of slices from each pancreas varied depending on the length, so the means calculated were based on differing numbers of samples. At least three

TABLE 2. *Abnormal Pancreases: Number of Islets Counted on a Circular Cross Section 6mm in Diameter*

	Sex	Age	Body Weight (lbs)	Pancreas Weight (gms)	Average Islet Concentration Head	Body	Tail	Uncinate
Diabetes mellitus	F	55	90	57	17.1	26.9	39.3	23.5
Chronic pancreatitis	M	50	180	170	5.7	10.9	17.8	—

TABLE 3. *Nine Normal Pancreases with Concentration of Islets in Head, Body, Tail and Uncinate: Number of Islets Counted on a Circular Cross Section 6mm in Diameter*

		Mean	Standard deviation
1.	Head	25.544	9.888
2.	Body	28.067	8.795
3.	Tail	45.700	17.037
4.	Uncinate	31.000	19.090

slices each and never more than ten slices were removed from the head, body and tail of the pancreas. Only one section was obtained from each uncinate but this was not judged to alter our results significantly.

According to Hellman,[1] medium sized islets contributed the greatest islet volume in all three regions of the pancreas, i.e., in the head, body and tail. Therefore, volume of islet tissue is quite directly related to the number of islets in each part of the gland.

Our study has shown that the islet concentration of the tail is significantly greater than the concentration in the head and body. The uncinate did not differ significatly from the tail, head or body.

Preservation of endocrine function, if at all possible, should be one consideration in the choice of operation in the nondiabetic patient with chronic pancreatitis. Iatrogenically induced diabetes can be a severe disability, particularly in patients who are unreliable as a result of addiction to narcotics or alcohol. If the tail rather than the head of the pancreas were left in situ at operation the chance of diabetes developing postoperatively would be less.

Reference

1. Hellman, B.: Histology: Actual Distribution of the Number and Volume of the Islets of Langerhans in Different Size Classes in Non-diabetic Humans of Varying Ages. Nature, 184:1498, 1959.