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Original Article

Anatomy Section

Morphometric Study of Pancreas in Human Fetuses

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ABSTRACT

Introduction: The pancreas arises from the endoderm as a dorsal and a ventral bud which fuse together to form the single organ. It extends transversely across the posterior abdominal wall from the duodenum to the spleen. Functionally, it is endocrine and exocrine.

Aim: This study was undertaken to study the morphometry of human pancreas at different gestational age groups of normal, still born fetuses.

Materials and Methods: Forty aborted human fetuses (25 male and 15 female) of 12-40 weeks gestational age with no obvious congenital abnormality were obtained. The fetuses were dissected and pancreas was removed. The length and weight of the pancreas as well as height of its head were noted.

Results: It was observed that there was increase in body weight and crown rump length with increasing gestational age. The average length of pancreas was 1.80 cm in 12th week and 4.70 cm in 40th week of gestation. The average height of pancreas head was 0.80 cm in the 12th and 2.70 cm in 40th week of gestation.

Conclusion: The knowledge of development of pancreas helps in planning new therapeutic interventions in the treatment of various congenital and functional pancreatic anomalies.

Keywords: Crown rump length, Gestational age, Still born

INTRODUCTION

The pancreas has both exocrine as well as endocrine functions. It arises from the endoderm as a dorsal and a ventral bud which fuse together to form the single organ. The secretions of the pancreas play an important role in the homeostasis of carbohydrate metabolism and regulating the glucose level in the blood. It extends transversely across the posterior abdominal wall from the duodenum to the spleen [1]. It has been studied in great detail in various animal species such as reptiles, mammals and amphibians. The mode of development of pancreas is similar in mammals, birds, reptiles and amphibians, while the islet cells are segregated as Brockmann bodies in some fishes [2]. Dysfunction of the pancreas results in diabetes mellitus. Diabetes itself is one of the earliest described diseases. The Eber's Papyrus dating back to 1500 B.C, mentioned it as a disease of polyuria [3]. In 1921, the outstanding discovery of insulin molecule by Banting and Best offered an exciting prospect for the treatment of diabetes. Fetal pancreatic islet transplantation is one of the most attractive strategies for the cure of type I diabetes mellitus. This field, with its research and clinical applications, has been particularly pursued by many workers in the recent years [4]. Research into the development of the pancreas has great implications in clinical practice and treatment protocol. Knowledge of development of human pancreas is important for success of replacement therapies in treatment of diabetes mellitus [5].

AIM

The present study aimed at morphometric development of fetal pancreas at different gestational age.

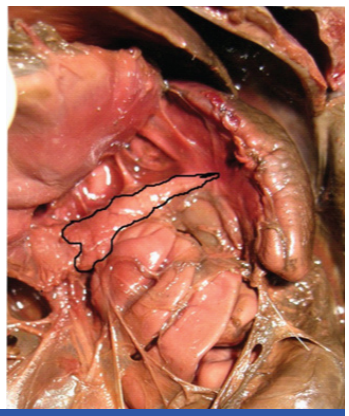
MATERIALS AND METHODS

This was a descriptive cross-sectional study conducted on fetal pancreas from July 2008 to January 2010 at Government Medical College, Miraj. The parameters considered were the body weight of fetus, crown rump length, pancreas weight, its length, the height of its head. Forty aborted human fetuses (25 male and 15 female) of 12-40 weeks gestational age with no obvious congenital abnormality were obtained with the permission from Department of Obstetrics and Gynaecology and prior consent of the parents. These fetuses included spontaneous abortions and stillborns. Fetuses were obtained within 4-5 hours of birth to avoid post-mortem changes. The sex, gestational age, weight and crown rump length were noted.

No specific reference was used to guide us for the method of dissection and measurements. A cruciate incision was taken on the anterior abdominal wall and the duodenum and pancreas were identified and removed from the abdominal cavity [Table/Fig-1,2]. The fetuses were weighed in double pan balance. The crown rump length recorded by using thread and scale. All these parameters were compared with the crown rump length and the gestational age.

RESULTS

The development of the pancreas was studied by considering different parameters of development. When there was more than one fetus at the given gestational age, the average of concerned parameter represented that age group. The parameters considered were the body weight of fetus, crown rump length, pancreas weight, its length, the height of its head. All these parameters were compared with the crown rump length and the gestational age.



[Table/Fig-1]: Fetuses of 38 and 16 weeks with the material used for the study.
[Table/Fig-2]: Pancreas seen in situ after reflecting the stomach in a 38th weeks fetus.

Gestational age (weeks)	Body weight (gm)	Crown rump length (cm)	Average Pancreas Weight (gm)	Relative Pancreas Weight (%)	Length of pancreas (cm)	Height of head (cm)
12	125	11.50	0.40	0.32	1.80	0.80
14	150	12.00	0.50	0.33	1.80	0.50
16	200	12.50	0.60	0.30	1.90	0.70
18	276	14.77	0.67	0.24	2.60	0.83
20	445	16.62	0.81	0.18	2.28	0.80
22	535	18.00	0.74	0.14	2.75	1.10
24	658	19.70	0.92	0.13	2.23	0.86
26	800	23.00	1.15	0.14	3.15	0.86
28	1425	26.70	1.64	0.12	3.50	1.60
30	1488	27.80	1.65	0.11	2.95	1.15
32	2000	30.40	1.91	0.10	3.45	1.55
34	2200	29.00	3.40	0.15	3.90	2.00
36	2250	32.00	3.00	0.13	3.80	2.40
38	2825	32.00	2.95	0.10	4.00	2.50
40	2825	35.00	4.03	0.14	4.70	2.70

[Table/Fig-3]: Various parameters at different gestational weeks.

The weight of the fetuses at different gestational age and the corresponding crown rump length were recorded in grams and centimeters respectively. It was observed that, there was increase in body weight and crown rump length with increasing gestational age. The average body weight of fetus was 125 gram at 12th weeks of gestation. It increased to 658 gram in 24th week and became 2825 gram at 40th week of gestation. The average crown rump length at 12th week was 11.50 cm. It was 19.70 cm at 24th week and 35 cm at 40th week. The weight of the pancreas at 12th week of gestation was 0.40 gram and it increased to 4.03 gram in the 40th week of gestation [Table/Fig-3]. The percentage relative weight was calculated by the following formula [6]:

$$\% \text{ Relative weight of pancreas} = \frac{\text{Pancreas weight X 100}}{\text{Body weight}}$$

The average of percentage relative weight was calculated for particular age group wherever appropriated. The percent relative weight of pancreas was 0.32% at 12th week of gestation. It was 0.13% in 24th week and 0.14% in 40th week of gestation.

The length of pancreas and the height of its head were measured in cm using vernier calipers. It was observed that, as the gestational age increases, the length of pancreas and height of its head also increases [Table/Fig-3].

DISCUSSION

Development includes three fundamental processes i.e., growth, differentiation and metabolism. Growth is increase in spatial dimensions and in weight. Differentiation is increase in complexity and organization [7]. Embryonically the pancreas arises between the 3rd and 4th week of gestation as a pair of evaginations of endodermal epithelium from the primitive gut. The endocrine part of the pancreas is distinguished by the 8th week of gestation. The exocrine part however is developed after 12th week. Throughout the pregnancy the pancreas shows increase in weight, length [8].

An increase in the body weight of the fetus was seen as the gestational age increased. At 12th week, the fetus weighed 125 gram. This weight increased gradually to 1425 gram at 28th week. Thereafter, the weight increased rapidly to 2825 gram at 40th week of gestation. The findings of body weight on comparison with previous studies shows, that the body weight of fetus at different gestational age reported by Greunwald [9] was more or less similar to the present study. The findings of Schultz [10] and Moore [11] showed weight less than the findings in the present study. The range of body weight given by Sadler was comparable with findings of the present study [Table/Fig-4] [12].

The crown rump length at 12th week gestation was 11.50 cm whereas, it was 35 cm at 40th week of gestation. From the [Table/Fig-5], it is seen that the values of crown rump length given by

Gestational Age (weeks)	Greunwald [9] 1960	Schulz [10] 1953	Hamilton [7] 1975	Sadler [12] 2006	Moore [11] 2008	Present Study 2016
14	-	-	-	60-200	110	150
16	-	-	120	-	200	200
18	-	-	-	250-450	320	276
20	-	-	300	-	460	445
22	-	330	-	500-820	630	535
24	638	-	635	-	820	658
26	845	767	-	900-1300	1000	800
28	1020	-	1220	-	1300	1425
30	1230	1110	-	1400-2100	1700	1488
32	1488	-	1700	-	2100	2000
34	1838	1718	-	2200-2900	2900	2200
36	2165	-	2400	-	3400	2250
38	2678	2476	-	3000-3400	-	2825
40	3063	-	3250	-	-	2825

[Table/Fig-4]: Showing comparison of body weight (in gram) of present study with the findings of other authors [7,9-12].

Gestational age (weeks)	Moore [11] 2008	Hamilton [7] 1975	Potter & Craig [13] 1976	Present study 2016
12	87	57-84	-	115
14	120	-	-	120
16	140	61-100	-	125
18	160	-	-	150
20	190	101-200	-	170
22	210	-	-	185
24	230	151-200	209	197
26	250	-	234	230
28	270	201-260	254	267
30	280	-	271	277
32	300	261-320	284	304
34	-	-	298	290
36	340	321-390	324	320
38	360	391-450	334	320
40	-	-	-	350

[Table/Fig-5]: Showing comparison of crown rump length (in cm) of present study with the findings of other authors [7,11,13].

Gestational Age	Robb [14]	Present Study
12	-	0.40
14	-	0.50
16	-	0.60
18	-	0.40
20	0.31	0.51
22	-	0.73
24	-	0.52
26	0.53	0.88
28	0.75	1.64
30	-	1.65
32	1.13	1.91
34	1.48	3.40
36	1.62	3.00
38	1.72	2.95
40	2.65	4.02

[Table/Fig-6]: Showing comparison of average weight of pancreas (in gm) of present study with the findings of another author [14].

Moore and Hamilton were more or less similar to the findings of the present study. The findings of Robb about average weight of pancreas showed gradual increase in pancreas weight as age progressed but at corresponding gestational age they were less as compared to present study [Table/Fig-6] [14]. The relative percentage weight of pancreas at 12th week was 0.32% and 0.14% at 40 weeks of gestation. Detailed findings from the previous studies were not available for comparison.

The present study shows that there was very less increase in the height of the head compared to increase in length of pancreas. The pancreas is situated in the concavity of the duodenum and once the duodenum becomes fixed retroperitoneally, there is very less space for the pancreas to increase vertically and so the developing pancreas grows towards the spleen. This could be attributed to faster growth of dorsal pancreatic bud than ventral bud [15].

LIMITATION

One of the limitations of the current study is the small sample size.

CONCLUSION

Fetal pancreatic islet transplantation is currently one of the most attractive strategies for the cure of Type I diabetes mellitus. The knowledge of development of pancreas helps in planning new therapeutic interventions in the treatment of various diseases related to pancreas, such as diabetes mellitus, carcinoma of pancreas, etc. The present study will help in understanding the growth and development of pancreas in fetal life. The data of the present study would also add knowledge to the existing literature.

AUTHOR'S CONTRIBUTION

Abhijeet S. Dhende and Mahendra A. Kathole contributed in collection of specimen's and dissection, analysis and interpretation of data, review of literature, writing and editing of the manuscript. Deepak S. Joshi guided us throughout this study. He mainly contributed in analysis and interpretation of data and manuscript writing.

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