

A Human Embryo of Streeter Age Group XVI

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=Abstract=A human embryo obtained incidentally from a hysterectomized uterus was examined. A total of 204 sections of slides was made and observed microscopically to determine the age of the embryo.

The upper and lower limb buds were recognizable but digital rays were absent. The embryo showed early differentiation of semilunar valves, aorticopulmonary septum, renal pelvis forming upper and lower poles and appearance of pigment granules in the outer coat of retina.

There was no vermiform appendix, and the dorsal and ventral pancreata had not yet fused. Any abnormality was not recognizable.

From the above findings, we concluded that this embryo belonged to the age group XVI of Streeter's developmental horizon.

Key words: *Embryo, Development, Streeter age group*

INTRODUCTION

It has been possible to arrive at a comprehensive understanding of the developmental processes of the human embryo in its entirety by assessing the estimate of the embryonic age. The lack of an agreeable and reasonable criteria for classifying the embryo into its respective age groups, however, has been a major hindrance, especially for embryos of early stage. Also, estimation of age based on the last menstrual period was not a reliable criterion as embryos of same ovulation age do not necessarily proceed at equal rate of growth and organogenesis.

In the effort to resolve this problem, George L. Streeter in 1948 established and introduced the concept of "Developmental Horizon" or "Age Group" formulated from his experiences with a large number of human specimens. On the basis of identifiable features of major internal organs constituting constellations characteristic of respective age groups, Streeter divided the developmental stages of human embryos into 23 age groups with an interval of 2 to 3 days. He thereby made possible the placing of embryos into their appropriate horizons.

In this study, we report findings of a human embryo with which it was possible to determine the

developmental stage in accordance to Streeter's descriptive criteria.

CASE REPORT

The embryo (ESR #59) discovered incidentally during a hysterectomy procedure was fixed in 10% formalin, embedded in paraffin and sectioned serially. During the preparatory process, however, the embryo was separated into head and body portions, resulting in the head portion sectioned transversely and the body part, obliquely.

1. External appearance

Because of the fragmented nature of the specimen the external appearance could not be drawn schematically.

2. Central nervous system and sensory organs

The embryo showed definite cephalic, pontine and cervical flexures which became more obvious after reconstruction (Fig. 1). First the cerebral vesicle was still composed of a thin cerebral mantle with prominent ventricular system which was already divided into lateral, third and fourth ventricles. The foramen of Monro was relatively large and connecting the lateral ventricles to the third ventricle. There was not hint of choroid plexus in the

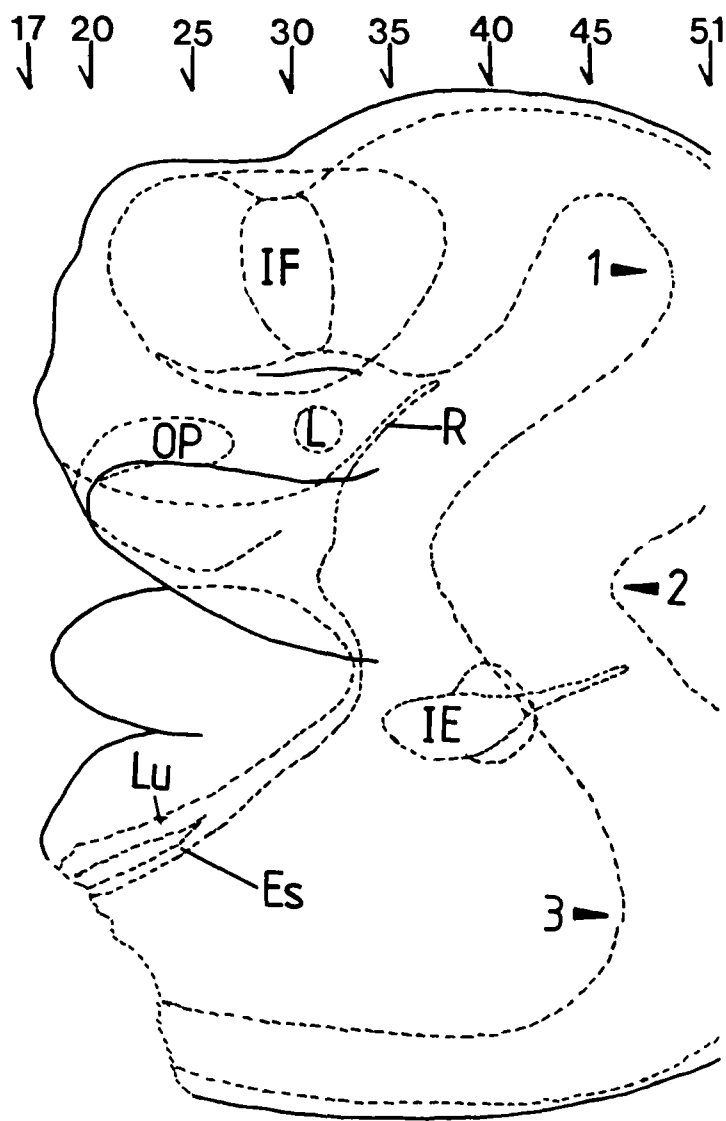


Fig. 1. Schematic reconstruction of central nervous system of embryo. Number represents the number of section slide.
 IF: interventricular foramen of Monroe
 IE: inner ear
 L: lens
 R: Rathke's pouch
 ES: Esophagus
 Lu: Lung
 OP: olfactory pit.
 1-: cephalic flexure
 2-: pontine flexure
 3-: cervical flexure

hind brain. Olfactory evagination was also absent. The posterior lobe of the hypophysis was slightly evaginated in section #36-3. There was a thickened portion of lamina terminalis which would later become the optic chiasm (#31-2). The pineal gland appeared as a small evagination of the roof of the posterior part of the diencephalon in slide #38-1. Four distinct cranial ganglia were found, presumed to be the trigeminal (V), facial (VII), vestibulocochlear (VIII) and vagal (X) nerve ganglia. The

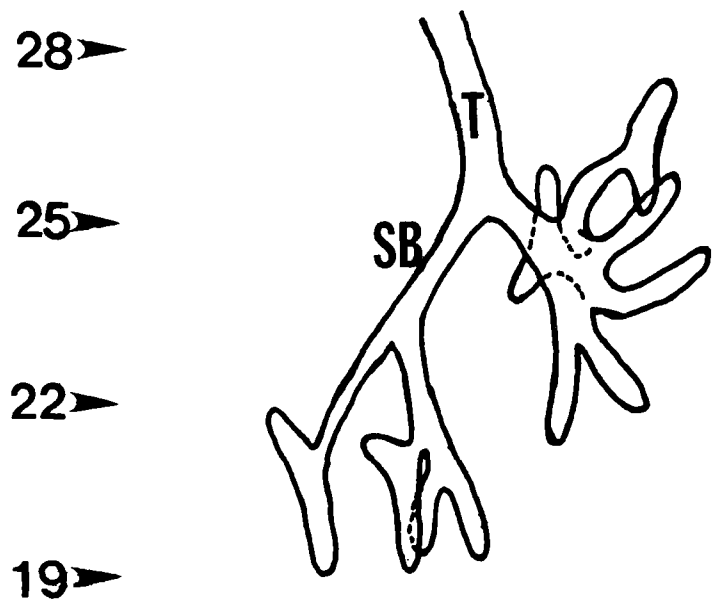


Fig. 2. Schematic reconstruction of the lungs of the embryo. The lobes of lungs can not be clearly distinguished
 T: trachea
 SB: stem bronchus

spinal cord showed a narrow lumen of the neural tube and dorsal root ganglia from which extensions of nerve fibers were observed. The eye was observed through sections #28-4 to #35-4. The lens vesicle was detached from the skin epithelium and the base of the lens vesicle exhibited the beginning of lens fiber differentiation. The lens cavity was relatively large and was of semilunar shape in midline section (#31-3). Although pigment granules were present in the outer coat of retina (#31-3) there was no inward migration of any of the retinal cells, indicating that the inner nuclear layer was not yet differentiated. There were found small clusters of disintegrating cells in the lens cavity, being the remnants of unwanted elements extruded by the lens plate epithelium during its invagination. The inner ear was observed in slides #34-4, #45-4 and #35-2 to #45-4. A prominent character was a relatively long endolymphatic appendage (#34-2 to #45-4). The walls of vestibular outpocketing were nearly apposed and appeared in #39-2. The optic ganglion and its nerve fibers were connected with the inner ear in #31-1. The external auditory meatus was also found as having formed from the first pharyngeal cleft (#32-3). The roof of the mouth (stomodeum) sloped forward

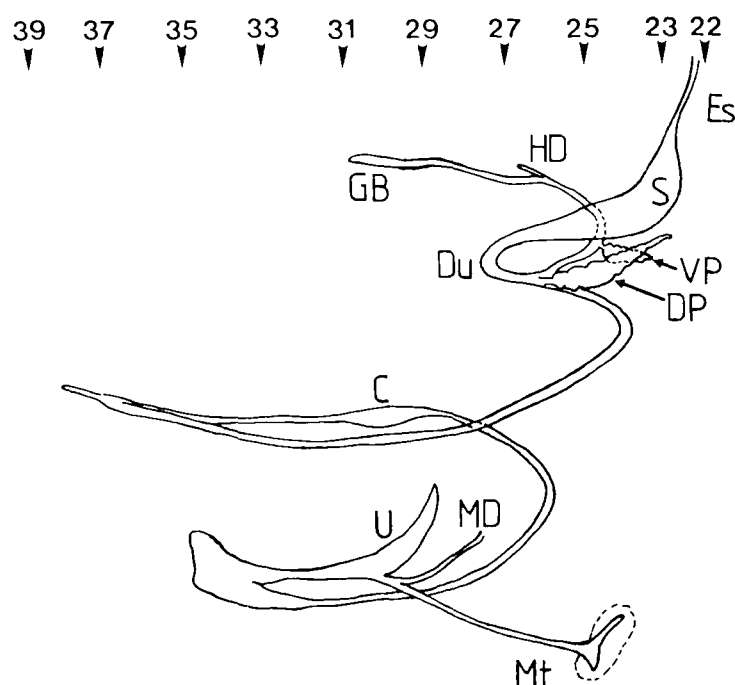


Fig. 3. Schematic reconstruction of the digestive system of the embryo.

C: cecum
Es: esophagus
GB: gallbladder
HD: hepatic duct
DU: duodenum
VP: ventral pancreas
DP: dorsal pancreas
MD: mesonephric duct
U: urachus
S: stomach
Mt: metanephros

between the olfactory pits and curved dorsalward over the forebrain. Along its course to the forebrain, the Rathke's pouch had become widened and flattened laterally.

3. Gastrointestinal system(Fig. 3)

The characteristic gut epithelium was surrounded by condensed visceral mesenchyme (# 33-1). In the doudenal region, the gut epithelium showed no distinct proliferation. The ventral pancreas was still found connected to the common bile duct and the dorsal and ventral pancreata were not yet fused but juxtaposed. The beginning of differentiation into the gallbladder and the hepatic duct was seen in #34-3 and #27-2 respectively, but intrahepatic biliary passage was not found. The liver filled most of the abdominal cavity. Hepatic cords anastomosed loosely around dilated sinusoids which were filled with normoblasts with

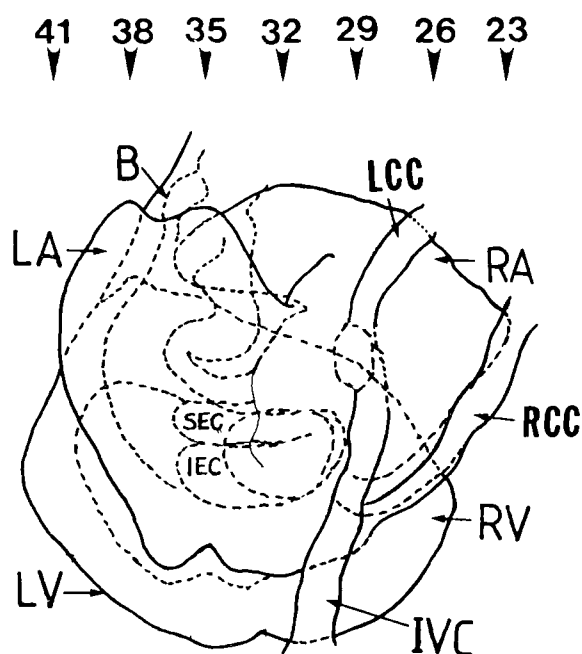


Fig. 4. Schematic reconstruction of the heart of the embryo. (dorsolateral view).

LA: left atrium
Ra: right atrium
LV: left ventricle
RV: right ventricle
B: bulbus cordis
SEC: superior endocardial cushion
IEC: inferior endocardial cushion
RCC: right common cardinal vein
LCC: left common cardinal vein

pyknotic nucleus and eosinophilic cytoplasm, but some areas showed polychromatic erythroblasts that formed extramedullary hematopoietic foci between the hepatic cell cords. The cecum portion showed bulging and the vermiform appendix was not yet present (#32-2). The splenic bud could be seen as localized condensation of mesenchymal cells in dorsal mesogastrium (#18-1). Rotation of the gut was minimal.

4. Respiratory system

The schematic reconstruction of the bronchial tree (Fig. 2) revealed a main bronchus with definite elongating primary bronchi, some having secondary branches. Since the lobes of the lungs could not be clearly distinguished, the number of the lobes could not be determined.

5. Cardiovascular system

The heart had 4 chambers, consisting of 2 atria and 2 ventricles (Fig. 4). The central part of the wide atrioventricular canal showed that the fusion of the opposing surfaces of the endothelium had

already proceeded (#30-4). Bulbus cordis was connected mainly with the right ventricle and the aorticopulmonary septum was already formed (#35-3). The aorta was posterior to the pulmonary trunk and the majority of blood cells were in the aorta. Venous valve (#30-3), septum primum (#33-1) and ostium primum (#33-2) were observed but septum secundum was not definitely recognizable. Vitelline veins entered the liver and formed hepatic sinusoids, and then connected with the right atrium as a hepatocardiac channel. The right common cardinal vein curved beneath the right atrium and emptied into it. The ventricle had muscular septum but not membranous septum as of yet. Cross striations were not seen in the cardiac muscle. As the aortic arch portion and its connections were lost unfortunately during the preparatory process, observations of this area could not be made.

6. Urogenital system

The metanephros began to appear in #23-3 on the right side and in #26-4 on the left side. The elongated ureteric bud expanded into the renal pelvis, forming the upper and lower poles (#25-1, Fig. 3) and these were surrounded by metanephric blastema. Mesonephric duct gave rise to ureteric bud near the cloaca.

7. Others

The thyroid gland was observed from section #24-1 to #27-1. The thyroid was bilobed and connected by a narrow isthmus in #24-2. The primitive cells of the thyroid were in cord-like arrangement and the gland was dorsolaterally extended with two vessels seen under it bilaterally. Thyroid follicles were not yet formed. The parathyroid glands were observed in sections #28-1 and #27-2 on the left and right sides, respectively. They appeared as solid cell nests with relatively abundant and clear cytoplasm. The proliferated mesodermal tissue in the second pharyngeal arch almost overlapped the third and fourth arches. The cavity (cervical sinus) however, was not completely formed (#28-2). The thymus appeared as ventral outgrowths of the third pharyngeal pouch in #27-3. Maxillary and mandibular swellings were visible (#20-3), the mandibular swelling forming the lower jaw. The maxillary swelling was not so great that the distance between the two olfactory pits was of considerable length. The maxillary swelling seemed to be on the verge of uniting with lateral nasal swelling and these structures were separated by a nasolacrimal groove. Upper and lower limb

buds were recognizable but digital rays were not yet in appearance. The lower limb bud showed 3 regions (1) #15-1, 2) #19-1 and 3) #19-3) in which nerve trunks terminated.

DISCUSSION

In summary, a general impression is made on the basis of the overall differentiating process of this embryo that this embryo perhaps belongs to the fairly young age group somewhere between X' and XVII of Streeter's developmental stages.

The stages XV and XVI are differentiated by noting the characteristics of the eyeball, hypophysis, heart and bowel. Since the features noted in this embryo suggestive of having surpassed stage XV include appearance of definite pigment granules in the outer coat of retina, evagination of posterior lobe of hypophysis (neurohypophysis), elongated ureter expanding into renal pelvis forming the upper and lower poles, and early differentiation of semilunar valves and aorticopulmonary septum, this embryo could be considered as belonging to at least stage XVI or more.

As to the possibility of this embryo being in stage XVII, the morphology of the ear certainly indicates stage XVII rather than stage XVI. The features of the walls of vestibular part of the labyrinth, although somewhat approximated in this case, together with the recognition of their thinning out were definite advanced for stage XVI and consistent with stage XVII. In order to be assigned stage XVII, however, invagination of the bile duct, inward migration of retinal cells, distinction of vermiform appendix, fusion of dorsal and ventral pancreata and separation of the right and the left atrioventricular canal should be present simultaneously. In this case since none of these decisive findings were present despite the minor discrepancy of the inner ear not being a characteristic of stage XVII it seems best to categorize this embryo into stage XVI.

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= 국문초록 =

사람배아(Streeter 연령군 XVI)의 1예

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지제근 · 한경일

저자들은 자궁적출 표본에서 우연히 발견된 배아를 연속절편하여 204절편을 통하여 관찰한 결과 본 배아가 Streeter연령군 제16군에 해당한다고 판단되어 이를 기술하였다.

본 배아의 특징은 다음과 같았다. 상하지는 limb bud로 나타나 있었으나 digital ray는 없었다. 심장의 반월판의 초기분화, 대동맥 폐동맥 중격의 존재, 신우의 상하극 분화 그리고 망막의 외막에 색소과립출현이 있었다. 충수는 없었고 복측 및 배측 체장은 융합되지 않았다.

LEGENDS FOR PLATES

- Plate 1. The neural tube (NT) and several spinal ganglia(SG) H&E, X40 (#3-2)
- Plate 2. The otic ganglion (OG). An arrow indicates nerve fibers which are connected with the inner ear. H&E, X40 (#37-1)
- Plate 3. The trigeminal nerve ganglion (TG), flattened Rathke's pouch(R) and evaginating neurohypophysis. H&E, X40 (#36-3)
- Plate 4. The cranial nerve ganglia (arros). H&E, X40 (#33-1)
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- Plate 21. The thyroid gland(T). It is bilobed. H&E, X40 (#24-2)
- Plate 22. The parathyroid gland(p). It appears as a small nodule in third pharyngeal arch. Note the second arch swelling nearly overlaps the third and fourth arches. (arrow with 2 heads). H&E, X40 (#28-1)
- Plate 23. The thymus(Ts). It appears as a ventral outgrowths of the third pharyngeal arch. H&E, X40 (#27-3)
- Plate 24. Maxillary swelling(MS), nasolacrimal groove(NG) and two olfactory pits(OP). H&E, X40 (#20-3)
- Plate 25. The esophagus (ES) and lung(L). H&E, X40 (#28-4)
- Plate 26. The upper limb bud. Digital rays is not seen. H&E, X40 (#36-1)
- Plate 27-30. The lower limb shows 3 or 4 regions which nerve trunks terminate in. H&E, X40 (#15-1, #21-4, #20-4. #19-1).

