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تكوين الحبل الشوكي في الأرنب

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يكون الحبل الشوكي جزءا كبيرا من الجهاز العصبي المركزي وتهدف هذه الدراسة الى التعرف على الاعمدة الخلوية وموعد ظهورها في المادة السنجابية للأرنب . ويتكون الحبل الشوكي نتيجة للزيادة والهجرة والتميز للخلايا العصبية .

تنطوي الصفيحة العصبية الى أخذ ود عصبي وبعد أربعة عشر يوما من الولادة تلتحم فقط عند المستوى الأوسط للجنين وبعد اليوم السادس عشر تتكون القناة العصبية بطبقاتها الثلاثة المتميزة . وتزداد القناة العصبية في النمو في الاتجاه البطني الظهرى والعلوى السفلى .

يتكون القرن السنجابي بعد اليوم السادس عشر للجنين بينما يتكون القرن الوحشي والظهري بعد ذلك بيومين . تنحصر خلايا القرن البطني في ثلاث مجموعات (١) مجموعة وحشية ، (٢) مجموعة مركزية (٣) مجموعة متوسطة ، وذلك بعد اليوم السادس عشر للجنين بينما تتميز الخلايا السنجابية المتوسطة بعد اليوم الثاني والعشرين للجنين وتظهر خلايا القرن الظهرى بوضوح بعد اليوم الرابع والعشرين من الحمل .

توجد أربعة مراحل في تكوين الخلية والمجموعات الخلوية :

- ١- مرحلة التميز
- ٢- مرحلة التشقق
- ٣- مرحلة التجميع
- ٤- مرحلة ظهور حبيبات نسل .

وقد قورنت هذه المجموعات الخلوية بمجموعات الفقاريات الأخرى وقد وجد تشابه كبير بين المجموعات الخلوية في الأرنب والانسان .

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Second main paragraph of handwritten text, continuing the narrative or discussion.

Third main paragraph of handwritten text, possibly containing a list or specific details.

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HISTOGENESIS OF THE SPINAL CORD OF RABBIT (With 8 Figures)

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SUMMARY

The spinal cord forms a great part of the central nervous system. This stimulated many workers to study its development. The development of the spinal cord is the result of the proliferation, migration and differentiation of the neuroblasts. It arises from a thickened area of the ectoderm (neural plate) which folds into a neural groove in the 12 days old embryo.

In the 14 days old embryo the neural folds fuse at the middle level of the embryo but cranially and caudally the neural folds stay apart until the age of 16 days when the neural folds are closed at all levels. The growth of the neural tube takes place along the ventrodorsal and rostrocaudal axes. The gray matter of the spinal cord has been subdivided into cell columns depending on the aggregation of the cells. Four distinct stages in the development of cells and cell columns in the gray matter of the spinal cord of Boscat Rabbit are distinguished : Stage of differentiation, stage of the appearance of cell groups, stage of splitting and the stage of Nissl granule appearance. The cell groups in the rabbit are compared with those of other vertebrates.

INTRODUCTION

HAMILTON and MOSSMAN (1972) in man and Di VIRGILIO *et al.* (1967) in chick mentioned that the material basis of the brain and spinal cord is the neural plate which is transformed into the neural tube. The cells of the neural tube are differentiated into three layers : an inner ependymal, a middle mantle and an outer non nucleated marginal layer. The proliferation is limited to the ependymal layer (HAMBURGER, 1948). As a result of the proliferative activity, the developing spinal cord initially possesses a pair of thick lateral walls, thin roof and floor plates and a narrow cleft-like lumen. The ventral half of the tube is called the basal lamina and the dorsal half is called the alar lamina. LANGMAN and HADEN (1970) observed that in chick following the closure of the neural tube the neuroepithelial cells begin to give rise to neuroblasts. ANGULO (1940) in rat; ROMANE (1941) in rabbit and REXED (1952, 1954 & 1964) in cat paid a great attention to the arrangement of cell groups in columns and laminae. The aim of this work is to detect the time of differentiation of the cell columns in each horn.

MATERIAL and METHODS

Sixty embryos divided into ten age groups were used in this study. Six embryos were taken from three pregnant females for each age group. The embryos were collected at 12, 14, 16, 18, 20, 22, 24, 26, 28, 30 days of gestation and fixed in Bouin's fluid. Large embryos (16, 8, 20, 22 days old) were decalcified in neutral ethylene diaminetetra acetic acid (E.D.T.A.). Paraffin serial transverse sections were cut at 10 μ and mounted with an adhesive. The sections were stained by Einarson Galloxyanine method (DRURY and WALLINGTON, 1980).

RESULTS

The neural plate folds into a neural groove which is bound on each side by an elevated fold in the 12 days old embryo (Fig. 1). The neural fold is thickened by the proliferation of its cells. In 14 days old embryo, the neural folds are fused together dorsally at the middle level of the embryo forming the neural tube (Fig. 2). Cranially and caudally however the neural folds stay apart until at the age of 16 days when the neural folds are closed at all levels of the embryo. The main period of mitotic activity extends from the 12th to the 18th day of embryonic life, the peak occurs in the 14 days old embryo. Starting from the age of 18 days cellular proliferation declines sharply to terminate in the 22 days old embryo (Fig. 3). In the 16 days old embryo, the cells in the ventrolateral part of the mantle zone start to differentiate as they become large in size and widely dispersed at all levels of the cord (Fig. 4). At the cervical level these cells become differentiated into three groups, the medial, central and lateral groups (Fig. 5). The ventral gray horn is formed at this stage. In the 18 days old embryo, the cells of the ventrolateral part of the other remaining levels are differentiated into lateral and medial groups (Fig. 6). Also a lateral gray horn is formed at the Sacral, upper lumbar and thoracic levels. The dorsal gray horn is formed at the same time with undifferentiated cells from the alar plate. The intermediate horn cells are differentiated in the 22 days old embryo and become clear in the 24 days old embryo while the dorsal horn cells are clearly differentiated in 24 and 26 days stages. In the 24 days old embryo the ventral gray horn at the cervical, lumbar and sacral levels showed the following columns: the ventromedial, dorsomedial, ventrolateral, dorsolateral and central columns in between the medial and lateral groups as well as the retrodorsal and ventral commissural nucleus (Fig. 7). While at the thoracic level only the ventromedial, dorsomedial, retrodorsal columns and the ventral commissural nucleus are identified (Fig. 8). In the dorsal gray horn the reticular nucleus, dorsal nucleus, central nucleus, substantia gelatinosa and the marginal layer are clearly seen and are arranged in a ventrodorsal direction.

DISCUSSION

According to the present study, the spinal cord of rabbit, like in most of the vertebrates, arises from the thickened area of the ectoderm (neural plate) which is lying along the midaxial line of the embryo. In 12 days old embryo the neural plate folds into the neural groove which is bound on each side by an elevated fold. In 14 days old embryo the neural folds are fused together dorsally at the middle level of the embryo only forming the neural tube. However ROMANES (1941) observed that in rabbit, the neural folds are fused together at all levels in the 11 days old embryo. This may be attributed to strain differences or to the effect of the environment.

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The growth of the neural tube takes place along the ventrodorsal and rostrocaudal axes. This is explained by the fact that 1) the ependymal zone becomes less in thickness ventrally than dorsally as a result of migration of its cells in the immediate vicinity of the mantle zone 2) the mantle zone is well formed ventrally than dorsally 3) the marginal zone is thicker ventrally than dorsally and completely surrounds the mantle zone. In the 16 days old embryo, the cells in the ventrolateral part of the mantle zone are the first cells to be differentiated at all levels of the cord. At the cervical level these cells become differentiated into three groups, the medial, central and lateral groups. The observations are in line with those obtained by ROMANES (1941) in rabbit and ANGULO (1940) in rat. ROMANES (1941) observed that in rabbit the first cells to be differentiated appear in the 12 days old embryo. This may be attributed to the early closure of the neural tube in rabbit in the 11 days old embryo. It is concluded, that the process of cell differentiation begins as soon as the complete closure of the neural tube.

Mitotic figures are limited to the ependymal zone. This is in agreement with MARTIN and LANGMAN (1965) and Di VIRGILIO *et al.* (1967) in chick and HAMILTON and MOSSMAN (1972) in man. It was found that the peak of mitotic activity occurs at the 14 days old embryo which corresponds to the time of differentiation of the neural tube into 3 layers.

The gray matter of the spinal cord has been subdivided into cell columns or laminae according to various criteria. The present work on Boscat Rabbit is based on the aggregation of cells to form columns in the same way WARWICK and WILLIAM (1973) based their study.

The results show four distinct stages in the development of cells and cell groups in the gray matter of the spinal cord of Boscat Rabbit.

1) A stage of differentiation of the cells extending from the 16 to 24 days of age and is characterized by the decrease in their density of staining.

2) A stage of the appearance of cell groups. At the cervical level of the 10 days old embryo, medial, central and lateral groups appear. In 18 days old embryo grouping extends to include the lumbar level, where lateral and medial groups are visible.

3) Stage of splitting : By the age of 24 days the lateral group is split into ventrolateral and dorsolateral columns and the medial group is split into ventromedial and dorsomedial columns. According to NOBACK and DEMARCET (1975), the medial group contains the neurons innervating the neck, back, intercostal and abdominal musculature while the lateral group contains the neurons innervating the musculature of the limbs. Hence this lateral group is prominent in the cervical and lumbar enlargements. This was confirmed by the experimental work of SPRAGUE (1948) in monkey and ROMANES (1951) in cat. On the other hand the degree of motor cell grouping in the ventral horn is much less developed in amphibians and reptiles because of the less developed or absent limbs (NEAL and RAND, 1948; ROMANES, 1953 and YOUNG 1971). In the dorsal horn, the cell columns in the 24 days old embryo are more differentiated than in the age before as there are undifferentiated cells beside the differentiated one.

4) Stage of Nissl granule development. Fine Nissl granules are firstly seen in apolar and bipolar nerve cells of the ventral gray horn in the 16 and 18 days old embryo respectively. These granules become darkly stained especially in the cells of the ventral horn of the 24 days old embryo.

The cell grouping in the present work are clear and easily distinguished in 24, 26, 28 & 30 days old embryos. This may be attributed to two factors; the first one is that the

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fiber system is less developed in these ages and its development leads to wide dispersion of the cells. The second factor is the presence of many undifferentiated cells beside the differentiated ones.

Comparing the cytoarchitectonic laminae of CLARK (1926) and REXED (1952, 1954 & 1964) in cat with the present observations it seems that laminae, I, II, III, IV, V and VI correspond to the marginal layer, substantia gelatinosa, central nucleus of the dorsal horn, dorsal nucleus and the reticular nucleus respectively. The substantia gelatinosa corresponds to laminae II and III. Lamina VII corresponds to the intermediomedial and intermediolateral columns. Lamina VIII corresponds to the ventromedial and dorsomedial columns while lamina IX corresponds to the ventrolateral and dorsolateral columns. Lamina X which surrounds the central canal corresponds to ventral and dorsal commissural nuclei.

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LEGENDS

- Fig. (1) :** Section of the neural groove of a twelve days old embryo at the cranial level showing:
 (1) The neural crest. (2) Mitotic figures.
 (3) & (4) The outer and inner limiting membrane.
 Einarson's Gallocyanine X 200.
- Fig. (2) :** Section of the neural tube of 14 days old embryo at the middle level showing closed neural tube.
 Einarson's Gallocyanine X 31.25.
- Fig. (3) :** Section of the ventral third of the spinal cord of 16 days old embryo showing :
 (1) The cells of the ventrolateral part of the mantle zone.
 (2) The cells of the ependymal zone.
 Einarson's Gallocyanine X 125.
- Fig. (4) :** Mitotic figure of the spinal cord of rabbit at different ages.
- Fig. (5) :** Section of the right ventral quarter of the spinal cord of 16 days old embryo at the cervical level showing the lateral (L), medial (M) and central cell groups (C).
 Einarson's Gallocyanine X 250.
- Fig. (6) :** Section of the ventrolateral part of 18 days old embryo at the lumbar level showing (M) the medial and (L) Lateral cell groups.
 Einarson's Gallocyanine X 31.25.
- Fig. (7) :** Section of the spinal cord of 24 days old embryo at the cervical level showing :
 (1) ventrolateral (2) dorsolateral (3) central (4) ventromedial (5) dorsomedial (6) retrodorsal (7) intermediolateral and (8) inermidiomedial columns (9) reticular nucleus (10) central nucleus. (11) dorsal nucleus (12) substantia gelatinosa (13) marginal layer.
 Einarson's Gallocyanine X 125.
- Fig. (8) :** Section of the right half of the spinal cord of 24 days old embryo at the thoracic level showing :
 (1) ventromedial (2) dorsomedial (3) retrodorsal (4) intermediolateral and (5) inermidiomedial columns (6) reticular (7) central and (8) dorsal nuclei (9 & 10) dorsal and ventral commissural nuclei (11) marked anterior median fissure (12) substantia gelatinosa (13) marginal layer.
 Einarson's Gallocyanine X 125.

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