Prenatal Development and Activity of the Thyroid Gland of the Buffalo

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With 2 figures and 2 tables

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The evolution of the foetal thyroid gland as well as the other endocrine glands is affected by many factors during intrauterine life. The maternal endocrinological system during pregnancy as well as the placental hormones may play a role in controlling the activities of these glands. However, the relationship between maternal, placental and foetal factors is still obscure.

With the probable exception of the male bovine gonads, the foetal endocrinological system is known to be inactive throughout most of intrauterine life. Most investigators state that the self-activity of the foetal thyroid begins very late in foetal life (CATCHPOLE, 1959 and RHODES, 1969).

The foetal thyroid had been studied in the buffalo by FAYEZ and MOSTAFA (1965). Since the histogenesis and pattern of activity of the buffalo foetal thyroid needed further study, this work is devoted to clarify this point. Variations in the pattern of the thyroid activity during intrauterine life were also considered.

Material and Methods

The material consisted of the thyroid glands of eighty-three buffalo foeti (40 male and 43 female). The thyroid glands as well as other endocrine glands were dissected, trimmed, freed from fat and other extraneous connective tissue and weighed by means of a torsion balance to the nearest mg. The glands were fixed in 10% formalin, dehydrated and embedded in Altmanns paraffin. Sections of six microns thickness were stained by H. & E., and examined microscopically to follow the histogenesis of the thyroid glands in different stages of intrauterine life.

Microscopical examination included measurement of the diameter of the acini and the beginning of their formation, and the height of the surrounding cell wall in 50, mostly rounded, acini of each individual gland. The acini measured were randomly chosen from the centers of the sections studied, which in turn were taken from the centers of the individual glands.
Measurements were made with an eyepiece micrometer. The approximate concentration of the colloid in the acini of the individual glands was determined visually.

The foeti studied were grouped into 30 day periods according to the age of the foetus, which was determined from the CVR length according to the formula of Abdel-Raouf and El-Naggar (1968). The material studied was distributed accordingly over the period from the third to the tenth month of gestation (Table 1).

### Table 1
Distribution of the material

<table>
<thead>
<tr>
<th>Stage of gestation (months)</th>
<th>No. of foeti</th>
<th>Av. wt. of the thyroid glands (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>female</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
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<td>5</td>
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<td>7</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

* Standard deviation

### Results

The weight increment of the thyroid glands of the foeti of both sexes increased progressively during the whole of intrauterine life. The rate of growth shows, however, a more regular trend in the male thyroid than in the female.

The regression coefficients of the weight increment of the glands to the CVR length of the foeti, varies little in both sexes ($b_x = 47.81$ and $45.69$ for the male and female thyroids respectively).

### Table 2
Thyroid acinar diameter and height of cell walls in buffalo foeti

<table>
<thead>
<tr>
<th>Stage of gestation (months)</th>
<th>Diameter of the acini and height of cell walls</th>
<th>colloid conc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>height of walls of acini (microns)</td>
<td>diameter of acini (microns)</td>
</tr>
<tr>
<td></td>
<td>male</td>
<td>female</td>
</tr>
<tr>
<td>4</td>
<td>9.6 ± 1.2*</td>
<td>5.7 ± 1.5</td>
</tr>
<tr>
<td>5</td>
<td>10.1 ± 0.3</td>
<td>8.3 ± 1.3</td>
</tr>
<tr>
<td>6</td>
<td>9.5 ± 1.2</td>
<td>7.5 ± 0.9</td>
</tr>
<tr>
<td>7</td>
<td>8.8 ± 1.8</td>
<td>9.8 ± 0.2</td>
</tr>
<tr>
<td>8</td>
<td>8.7 ± 0.3</td>
<td>11.9 ± 1.9</td>
</tr>
<tr>
<td>9</td>
<td>9.6 ± 1.6</td>
<td>9.8 ± 1.9</td>
</tr>
<tr>
<td>10</td>
<td>11.0 ± 1.7</td>
<td>10.8 ± 1.8</td>
</tr>
</tbody>
</table>

* Standard deviation $b_x$ (between the weights of the glands and the CVR length of the male foeti) = 47.81.
$b_y$ (between the weights of the thyroid glands and the CVR length of the female foeti) = 45.69.
The weight of the thyroid glands in both sexes reaches at full term, however, more than 1000 times its weight in the third month of intrauterine life. Sex of the foetus shows no influence in this respect (Table 1, Fig. 1).

Cell cords in the substance of the thyroid gland are observed until the third month of pregnancy. Whereas in the male foeti acinus formation begins in the fourth month and exceptionally in the fifth month, it begins somewhat earlier in the female thyroid, where acini are observed exceptionally in the third month of foetal life.

Whereas the average height of the cell walls surrounding the acini continues nearly unchanged till birth, the diameter of formed acini increases progressively from the begin of its formation until birth (Table 2). Although the development of male and female thyroids shows a similar general trend, relatively large fluctuations in the trend of increase of both the height of the cell wall surrounding the acini and the diameter of the acini themselves monthly are observed in the female thyroids. The main apparent difference in the pattern of evolution between the male and the female thyroids is seen in the ninth month of foetal life, where a sudden increase in the diameter of the acini of the male thyroid is in contrast to a sudden fall in this diameter in the female thyroids in the similar period of pregnancy. The acini of the glands of both sexes retained, however, their normal average at the tenth month of foetal life (Table 2, Fig. 2).

Statistically highly significant correlations are observed between the CVR length of the foeti of both sexes and the average diameter of the acini.
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of the glands \(r = 0.761\) and \(0.532\) in the male and female thyroids, respectively.

Significant correlation is found between the height of the cells of the acini and the CVR length only in the female thyroids \((0.349)\). Similar correlation is not observed in the male thyroids \((r = 0.134)\).

The concentration of surface colloids in the acini shows increased concentrations with the age of the foetus from the fourth till the tenth month of pregnancy. A non-significant fall in the concentration of the colloids is, however, observed in the ninth month of pregnancy in foeti of both sexes. The highest concentration of the colloids is, however, observed in the last trimester of pregnancy, whereas the lowest concentration is seen in the fourth month of pregnancy in the thyroid of the male foeti. In the female foeti, on the other hand, the colloid concentration remains more or less constant throughout foetal life. The maximum concentration of the colloids is, however, demonstrated in the last months of foetal life.

Considering the diameter of the acini, the height of the cells of the walls of the acini and the concentration of the colloid surface in these acini as indicators for the level of activity of the thyroid gland (BOGUTH and FRENZEL, 1965), one can conclude that the activity of the foetal thyroid of both sexes coincides more or less with the weight increment of these glands. An exception is, however, observed in the ninth and tenth months of foetal life, where the activity of the glands remains more or less constant, or even falls, in the glands of the female foeti, whereas the increase in the weight of the glands continues more or less at the same rate as in the earlier months of the foetal life.

Discussion

Both the male and female foetal thyroids follow a similar pattern of evolution. The weight increment of both glands runs in two main phases; a rapid phase from the third to the sixth month, followed by a slower phase till the tenth month. No reference to this in the literature could be found (Table 1, Figure 1).

With an early start at the third month of foetal life in the case of female thyroid glands, and a slight retardation in the male thyroid gland, vacuolation of the gland begins at the fourth month of pregnancy. Similar findings were recorded by AMOR (1931), KONEFF, NICHOLS, WOLFF and CHAIKOFF (1949), in the bovine foetal thyroid, where vacuolation began in the second and third month of foetal age. HOGBEN and GREW (1923), found that acinus formation in the bovine foetal thyroid begins in the fourth month of foetal life.

FAYEZ and MOSTAFA (1965) recorded the appearance of the first acinus in the buffalo foetal thyroid at a foetal length of 14.0—16.5 cms. Sex variations were not considered by these authors.

Whereas the mean height of the cell wall shows no marked changes with foetal age during the evolution of the thyroid gland of the male foetus, irregularity is met with in the thyroids of the female foetus (Table 2, Fig. 2), where a significant correlation between the height of the cell wall and the CVR length of the foetus was observed.

The diameter of the formed acini increases regularly and gradually till birth, where the rate of increase of weight was lowest in the ninth and tenth months of foetal life. Whereas a sudden fall in the diameter of the acini is observed in the female thyroid in the ninth foetal month, a continuous increase in the similar period is seen in the male foetus. This can be considered the main difference observed in the pattern of evolution between the male and female thyroids (Table 2, Fig. 2). The maximum diameter of the acini is seen in the
ninth foetal month in the male foetus. No considerable differences in the diameter of the acini were observed between the male and female glands in the remaining foetal life.

Colloid materials began to accumulate as early as the fourth month of foetal life i.e. coinciding with the beginning of acinus formation. Similar observations were made by Hogben and Grew 1923, in the bovine foetal thyroid. The concentration of these colloids varies during foetal life to reach its maximum at the eight month (Table 2, Fig. 2) and then remains more or less constant till birth. Similar observations were reported by Arteemow and Vaelndenskeya who showed that iodine in the foetal bovine thyroid begins to accumulate at the moment of the first differentiation of its secretory epithelium. They also found that the amount of iodine in the thyroid of eight months old foeti was lower than at 5—7 months.

Different signs have been considered as indications of thyroid activity. Whereas Fayezy and Mostafa (1965) observed the activity of the buffalo foetal thyroid to begin at a foetal length of 30.0—37.0 cm., the present results shows earlier activity. The glandular activity of the thyroid, in the present study is assessed, however, by the height of the cells forming the walls of the acini, the diameter of the acini themselves as well as the approximate concentration of the surface colloids accumulated in the acini (Boguth and Frenzel, 1965). Accordingly, gland activity is found to increase gradually and more or less regularly in accordance with the age of the foetus as determined from the CVR length, beginning from the early differentiation of the acini at the third foetal month in the case of the female foetus and the fourth foetal month in the male foetus. Variations according to the sex of the foetus are observed only in the ninth month of foetal life, where a sudden increase in the gland activity in the male occurs and a sudden fall in activity in the female. The glands of both sexes retained similar activity levels at the tenth month of foetal life (Table 2, Fig. 2). An explanation for this variation is difficult to find. The role played by the maternal thyroid, as well as by the placenta, in this respect must not be underestimated.

Abdo (1962) observed a gradual decrease in the level of thyrotropic hormone in the blood of pregnant buffalo-cows, till the sixth month of pregnancy, followed by an increase in the level of this hormone in the seventh and eighth months of pregnancy. The level of thyrotropic hormone decreased again after the eight month of pregnancy. This statement suggests that the foetal thyroid is more or less controlled by the maternal thyrotropic hormone in its evolutionary activity at least until the eighth month of gestation, where the selfactivity of the foetal thyroid supervenes. The general agreement between investigators that the foetal thyroid begins its self-activity near full term, (Catchpole, 1959 and Rhodes, 1969) may support this suggestion. Signs of activity of the thyrotropic cells in the human foetal pituitary were observed to coincide almost with the beginning of differentiation of the acini in the foetal thyroid, which begins at the 53th day of foetal life in man (Conklin, 1968).

Acknowledgement

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Summary

A comparative study was made of the development of the thyroid glands of the male and female buffalo foetus between the third and the tenth months of intrauterine life.
The weight of the gland in male and female progressively increased. Although slow till the sixth month, the rate of the weight increment was markedly increased in the second half of pregnancy.

Acini were usually first observed in the fourth month of foetal life but, acinar differentiation can begin as early as the third month in the female and as late as the fifth month in the male.

Whereas the height of the cells forming the walls of the acini remained almost constant throughout intrauterine life in both sexes a progressive increase in the diameter of the acini in accordance with foetal age is observed and reaches its maximum in the last trimester of gestation. A sudden reduction in the size of the acini was observed in female glands at the ninth month of gestation and a sudden rise in the diameter of the acini in male glands, at the same time.

The concentration of the surface colloids fluctuated during the developmental stages but generally increased with foetal age in both sexes.

**Zusammenfassung**

**Pränatale Entwicklung und Aktivität der Schilddrüse beim Büffel**

Es wurde eine vergleichende Studie der Schilddrüsenentwicklung männlicher und weiblicher Büffel-Foeten während des dritten bis zehnten Graviditätsmonates durchgeführt.


Während die Höhe der Zellen, welche die Wände der Acini bilden, während des ganzen intrauterinen Lebens bei beiden Geschlechtern gleich blieben, wird der Durchmesser der Acini ständig größer und erreicht sein Maximum im letzten Trimester der Trächtigkeit. Im neunten Monat der Trächtigkeit wurde bei weiblichen Foeten eine plötzliche Verkleinerung der Acini beobachtet.


**Résumé**

**Développement prénatal et activité de la thyroïde du buffle**

On procède à une étude comparative sur le développement de la thyroïde chez des foetus de buffles mâles et femelles, du troisième au dixième mois de la gestation.

Le poids de la glande augmente progressivement chez le mâle comme chez la femelle. L'augmentation du poids est faible jusqu'au sixième mois et nettement plus élevée la deuxième moitié de la gestation. On observe les premiers acinus au quatrième mois de la vie foetale. Mais la différenciation des acinus peut commencer au troisième mois déjà chez les animaux femelles et au cinquième mois seulement chez les mâles.

Si la hauteur des cellules formant les parois des acinus reste identique pendant toute la vie intra-utérine chez les deux sexes, le diamètre des acinus grandit constamment et atteint son maximum au cours du dernier trimestre de
la gestation. Au neuvième mois, on observe une diminution soudaine du diamètre des acinus dans les thyroïdes des foetus femelles et une augmentation du diamètre des acinus dans les glandes des mâles.

La concentration des colloïdes de surface varie en général pendant tout le développement foetal. La concentration des colloïdes augmente pendant la vie foetale chez les deux sexes.

Resumen

Desarrollo prenatal y actividad de la glándula tiroides del búfalo egipcio

Se realizó un estudio comparativo sobre el desarrollo del tiroides en los fetos masculinos y femeninos de búfalas en la edad comprendida entre el tercer y décimo meses de vida intrauterina.

Los pesos de la glándula aumentaban progresivamente en el macho y en la hembra. Aunque lenta hasta el sexto mes, la tasa de crecimiento era bastante mayor en la segunda mitad de la gestación. Los acini se observaron por vez primera en el cuarto mes de vida fetal. Excepcionalmente ya comienza la diferenciación de los acini en el tercer mes en las hembras y en el quinto mes en los machos.

Mientras que permanecía casi constante la altura de las células que forman las paredes de los acini, alcanzando su máximo durante el último trimestre de gestación. En el noveno mes de gestación se observó en los fetos femeninos una reducción repentina de los acini.

La concentración de los coloides superficiales fluctuaba durante todo el desarrollo fetal. En ambos sexos se registraba un aumento general en la concentración de coloides durante la época fetal.

References


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