GROSS AND MICRO-ANATOMICAL OBSERVATIONS ON Fulani Zebu PLACENTOME AND ITS RELATIONSHIP WITH SOME FOETAL PARAMETERS

Okafor C Lilian¹, Usende I Levi*¹, Ezeasor N Daniel¹ and Onyiche E ThankGod²

¹Department of Veterinary Anatomy, University of Nigeria, Nsukka.
²Department of Veterinary Microbiology and Parasitology, University of Ibadan, Nigeria.

Received: September 09, 2013; Revision: October 16, 2013; Accepted: October 30, 2013
Available Online November 21, 2013.

KEYWORDS
Gross
Micro-anatomical
Placentome
Fulani Zebu
Foetal parameters

ABSTRACT

This study aims to investigate the gross and micro-anatomy of the placentome of Fulani zebu (Bos indicus) and its relationship with some foetal parameters over the gestation period. Eighteen pregnant uteri of the Fulani zebu cow were collected from slaughtered pregnant cows. The foetal age was estimated using Richardson’s formula. Other foetal parameters such as the foetal sex, location in the uteri, foetal weight, placentome weight, total number of placentomes and placentome size were taken.

The Placentome counts showed a great deal of variability from 51 to 128. The distribution of pregnancies was (66.6% in the right horn and 33.3% in the left horn). Regression analysis was used to establish the relationship between the estimated age and other foetal parameters. The regression analysis yielded a statistically significant relationship (r² = 0.4549; p<0.001) between the age of the fetus and the placentome size; (r²=0.8055; p<0.001) between the age of the fetus and foetal weight; (r²=0.7567; p<0.01) between the age of the fetus and placentome weight; but the age of the fetus did not vary (P>0.01) with the number of placentome. In conclusion, this study has shown that the Fulani zebu placenta is synepitheliochorial with convex Placentomes. The placentome size increases with gestation age in response to greater nutrient/metabolic requirement of the foetus, as the pregnancy progresses.

* Corresponding author
E-mail: ifuska4life@yahoo.com (Usende I Levi)

Peer review under responsibility of Journal of Experimental Biology and Agricultural Sciences.
1 Introduction

Cattle today are the basis of a multi-billion dollar industry worldwide (Jaji et al., 2012). The international trade in beef for the year 2000 was over $30 billion and represented only 23 percent of world beef production (Clay, 2004). The world cattle population was estimated to be about 1.3 billion heads, with about 15 percent in Africa. Nigeria had a mean cattle population of 13.9 million in 1990, of which 11.5 million were kept in pastoral system and 2.4 million in villages. They were predominantly Zebu, Muturu, Keteku, N’dama and Kuri (Mason et al., 1989).

The placenta is the connection between the fetus and its dam that allows the physiological exchange of nutrients, hormones, gases and waste products (Mossman, 1987). The bovine placenta is classified as cotyledonary as it has multiple small areas of attachment. Villi appear on the fetal tissue and become embedded into the crypts in the caruncle (Wooding & Burton, 2008). However, Wooding (1992) showed that the chorion is directly opposed to the maternal epithelium although migration of specific binucleate cells from the fetal to the maternal epithelium does occur.

Placental development is linked to and pivotal to fetal development. This means that the gross morphometry of the bovine placenta changes markedly as gestation progresses and if this placent al development is markedly affected, then it can hinder fetal development (Folusho, 2012). The placentome is an interface between the maternal endometrium and the fetal trophoblast (Folusho, 2012). The placentomes are formed at about 30 days of gestation as a result of the attachment of the chorioallantois to the uterine epithelium (Schlafer et al., 2000). Normal placentome growth and development is essential for the establishment and maintenance of pregnancy and for normal fetal growth and development (Laven & Peters, 2001) hence, the placentome is a crucial component of the bovine placenta. The placentome is also a major site for placental steroidogenesis (Hoffmann & Schuler, 2002). The placentomes are distributed in both horns of each uterus and varied in number, size and shape. Mossman (1987) reported that the number of placentomes in the cow varied from around 50 to 175 per uterus. Laven & Peters (2001) reported that placentome numbers were markedly higher in the pregnant horn than the non-pregnant one. Also, a positive correlation has been reported between increase in placenta weight and foetal weight (Reynolds et al., 1990).

Despite the importance of cattle to the agricultural economy, there has been only limited study of placental development in cattle and hence there is need to evaluate such studies in the Fulani zebu and its relationship with some foetal parameters over the gestation period.

2 Materials and Methods

2.1 Collection of Materials

The study was carried out in the Nsukka Municipal Abattoir and a total of 18 pregnant uteri of the Fulani zebu cow were collected. The samples were transported to the Veterinary anatomy laboratory. The pregnant uteri were carefully dissected out using surgical blades, scissors and forceps to display the placentomes in such a way that they were intact, maintaining their connection to the foetus through the umbilical cord.

2.2 Gross examination of the specimen

Grossly, the location of the fetuses in the left or right horns of the gravid uteri was noted then weighed in kilograms. Richardson’s et al. (1990) formula was used to determine the foetal age X = 2.5 (Y + 21), where X = the developmental age in days; Y = Crown – anus length measured in cm. The uteri were dissected to expose the placentomes, the distribution of the placentomes were noted in the left and right horns of the gravid uterus. Placentomes were then severed from the endometrium by cutting through the upper part of the caruncular stalk. They were counted, measured in cm using divider and ruler. The sex of the fetuses was also noted.

2.3 Histological Examination of the specimen

The protocol for histological preparations was according to the methods of Wooding (2006). Whole placentomes were cut free and placed in petri dishes containing 10% neutral-buffered formalin. The positioning of the placentome was such that the foetal side was uppermost. The placentomes were sliced across the centre to produce 3-4 mm thick samples, the full depth of the placentome. These were fixed by immersion in 10% neutral-buffered formalin. The samples were dehydrated in increasing concentrations of ethanol, cleared in xylene and embedded in paraffin. Sections of 5-6 μm thickness were cut and stained with haematoxylin and eosin (H&E) for light microscopy. Photomicrographs were captured using a Motic China Group Ltd., attached to an Olympus binocular microscope at magnification of X 40.

2.4 Statistical analyses

Regression analyses (Graph Pad Prism Version 5) were used to evaluate the relationship between the estimated age and foetal weight, the relationship between the estimated age and placentome weight, the relationship between the estimated age and number of placentome and finally the relationship between the estimated age and placentome size.

3 Results and Discussion

A total of 18 foetuses of various ages were collected from the reproductive tracts of Fulani Zebu cow slaughtered at the Nsukka municipal abattoir.

3.1 Gross Anatomical Findings
Twelve foetuses occurred in the right horn of the uterus and only 6 in the left horn. While male fetuses predominated in the right horn than the left, female fetuses appeared almost equally distributed (4 to the left and 3 to the right) Table I. Placentomes were displayed in pairs on either side of the horns with those seen in the gravid horn predominating both in size and number (Figure 1). Placentomes from the non-gravid horns were smaller both in size and number (Figure 2). The shape of the placentomes varied from oval, round, spherical to ellipsoidal. The placentomes had a convex appearance. In younger fetuses, the caruncles were observed to be pale in colour whereas in older fetuses, they become more vascularized and deep red in colour.

Figure 1 Photograph of the inside of uterus of a Fulani Zebu cow showing the foetus (F) and distribution of placentomes (P) in pairs on the right (RH) and left (LH) horns. Note the presence of interplacentomal areas (A) and the umbilical stalk (UB).

Figure 2 Photograph of the cotyledonary placenta of the Fulani zebu cattle showing convex-shaped oval, round, spherical to ellipsoidal placentomes (P) and interplacentomal areas (A). The chorionic plate (arrow) forms the convex face of the placentome.
Table 1 Foetal Parameters of the Fulani Zebu Cattle during pregnancy.

<table>
<thead>
<tr>
<th>Estimated age (days)</th>
<th>105</th>
<th>114</th>
<th>129</th>
<th>138</th>
<th>139</th>
<th>146</th>
<th>153</th>
<th>154</th>
<th>160</th>
<th>169</th>
<th>171</th>
<th>177</th>
<th>195</th>
<th>197</th>
<th>197</th>
<th>207</th>
<th>224</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foetal sex</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Location in the uteri</td>
<td>R</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>L</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foetal weight (kg)</td>
<td>0.2</td>
<td>0.4</td>
<td>0.9</td>
<td>1.7</td>
<td>1.1</td>
<td>1.5</td>
<td>2.0</td>
<td>1.7</td>
<td>2.2</td>
<td>1.9</td>
<td>3.6</td>
<td>3.5</td>
<td>3.2</td>
<td>4.0</td>
<td>4.4</td>
<td>4.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Placentome weight (kg)</td>
<td>0.2</td>
<td>0.2</td>
<td>0.6</td>
<td>1.1</td>
<td>0.8</td>
<td>0.7</td>
<td>0.6</td>
<td>0.5</td>
<td>1.0</td>
<td>0.8</td>
<td>0.8</td>
<td>1.0</td>
<td>0.9</td>
<td>1.2</td>
<td>1.4</td>
<td>2.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Total number of placentome</td>
<td>73</td>
<td>51</td>
<td>111</td>
<td>63</td>
<td>74</td>
<td>92</td>
<td>102</td>
<td>82</td>
<td>85</td>
<td>122</td>
<td>71</td>
<td>74</td>
<td>70</td>
<td>95</td>
<td>128</td>
<td>114</td>
<td>109</td>
</tr>
<tr>
<td>Gravid uterus</td>
<td>40</td>
<td>31</td>
<td>56</td>
<td>53</td>
<td>40</td>
<td>36</td>
<td>53</td>
<td>74</td>
<td>52</td>
<td>41</td>
<td>68</td>
<td>42</td>
<td>38</td>
<td>37</td>
<td>50</td>
<td>66</td>
<td>82</td>
</tr>
<tr>
<td>Non gravid uterus</td>
<td>33</td>
<td>20</td>
<td>55</td>
<td>61</td>
<td>23</td>
<td>38</td>
<td>39</td>
<td>28</td>
<td>30</td>
<td>44</td>
<td>54</td>
<td>29</td>
<td>36</td>
<td>33</td>
<td>45</td>
<td>62</td>
<td>32</td>
</tr>
<tr>
<td>Placentome size (cm)</td>
<td>2.56</td>
<td>2.58</td>
<td>3.27</td>
<td>2.95</td>
<td>4.16</td>
<td>3.99</td>
<td>3.35</td>
<td>3.05</td>
<td>4.06</td>
<td>3.25</td>
<td>3.09</td>
<td>4.61</td>
<td>3.18</td>
<td>3.94</td>
<td>4.62</td>
<td>3.80</td>
<td>4.09</td>
</tr>
</tbody>
</table>

Figure 3 Maternal Connective tissue (M), arteries (A) and veins (V). Note the uterine epithelium (E), and maternal blood capillaries (MBC). H&E stain, x400, Scale bar = 100 μm.

Figure 4 The terminus of the tertiary chorionic villus (TV). Note the foetomaternal junction (asterisk), the maternal connective tissue (CT) and dense collagenous fibrins (CF), giant mononucleated and binucleated cells (GC) and the numerous blood vessels (BV). H&E stain, x400, Scale bar = 100 μm.
The number of placentomes in the gravid uteri examined in this study ranged from 51 to 128, while the average size of placentomes at the different stages of gestation studied ranged from 2.56cm to 4.62cm (Table 1). Regression analysis yielded a statistically significant relationship ($r^2 = 0.4549; p<0.001$) between the age of the fetus and the placentome size; ($r^2=0.8055; p<0.001$) between the age of the fetus and foetal weight; ($r^2=0.7567; p<0.01$), and between the age of the fetus and placenta weight; but the age of the fetus did not vary ($P>0.01$) with the number of placentome.

3.2 Histological findings

The foetal part of the placentome comprised the chorionic plate which was smooth on the external surface. Sprouting from its internal surface are numerous primary villi which branched in a pinnate fashion producing secondary and tertiary villi (Figure 4 & 5). The latter of which interdigitate with the crypts in the maternal endometrium (Figure 5).

The external face of the chorionic plate was covered by a simple epithelium comprising of low cuboidal cells intermixed with giant mononucleated and binucleated cells. At certain locations, the epithelium appeared to be stratified cuboidal. Below the epithelium lies the core of the chorionic plate which was a typical mucoid connective tissue, pale staining and consisting of few delicate collagenous fibrins and an admixture of fibroblasts and typical mesenchymal cells, sections of large blood vessels namely arteries and veins were evident as well as capillaries (Figure 3, 4 & 5).

The connective tissue core extended into the villi within which there are prominent vessels, especially capillaries, some of which approximate more closely to the epithelium in the tertiary villi (Figure 3). Others are actually intraepithelial. The epithelial covering of the villi again is a simple layer with the preponderence of giant mononucleated and binucleated cells (Figure 4). The surface epithelium of the endometrium comprised a simple columnar epithelium which was lightly infiltrated on its basal aspect by migratory leukocytes. The crypts were lined by cuboidal cells throughout although the cells tended to be lower at the deep portion of the crypts. Occasional giant cells were found in the epithelial lining (Figure 4 & 5).

This study has provided an insight into the assessment of the growth of bovine foetus and some of the accompanying structures over the course of gestation. The placenta is a very vascular foetal organ whose main function is to exchange nutrients, metabolic products and gases between the maternal and foetal blood streams. The size of the placenta increases during the foetal growth period to enable it performs its vital functions. The placentae of humans, cattle, horses and dogs are all very different from one another at both gross and histologic levels. Placental development is a key requirement for fetal growth during gestation such that impairment of placental growth could result in retarded development as well as retention of the fetal membranes during parturition (Boos et al., 2003).

Figure 5 Placentome showing maternal connective tissue (MCT) with delicate collagen fibrins. Note the maternal blood vessel (MBV) and interdigitation of the maternal chorionic villi (MCV) and the foetal villi (FV) forming a crypt (C) H&E stain, x100, Scale bar = 100 μm.

Journal of Experimental Biology and Agricultural Sciences
http://www.jebas.org
This result shows that the placentomes of the Fulani zebu cattle are convex-shaped and are randomly distributed in the placenta but differs markedly from the concave shaped of the West African Dwarf goat as reported by Igwebuike & Ezeasor (2013). Stressors such as under nutrition, cortisol administration, carunculectomy and high temperature can cause a change in placentome shape in sheep (Steyn et al., 2001).

The Placentome counts showed a great deal of variability from 51 to 128 in the present study. This was different from 63 -113 in the Angoni and 47 – 120 in the Barotse both typically adapted in the East Africa cattle (Rakha & Igboeli, 1971). Therefore, the placenta can be described as synepitheliochorial according to classification by Wooding (1992).

The distribution of pregnancies (66.6% in the right horn and 33.3% in the left horn) is in accordance with previous studies (Latshaw, 1987; Noakes, 2001). The authors speculated that it might be due to the location of the rumen in the left side thus imposing space limitations to the developing foetus in the left horn of the uterus.

There is a significant linear association throughout pregnancy between foetal weight and placentome weight. There was an indication that at the early stages of gestation, foetal weight was much lower than weight of placentomes till day 120 from which time foetal weight surpassed placentome weight to the extent that the former was close to eight times that of the latter close to parturition. The increase in fetal weight relative to placental weight in the early stages of gestation is probably due to increases in placentome vascularity, thereby increasing feto-maternal exchange without affecting placental weight (Leiser et al., 1997).

Placentome number was higher in the pregnant horn than the non-pregnant one. This is consistent with the findings of Laven & Peters (2001). Furthermore, the number of placentomes had no significant relationship with foetal age. Varying status of health and nutrition will profoundly affect the rate of development of the placenta in domestic animals even those within the same age group. This may contribute to the variability exhibited in placentome populations here and subsequent lack of any relationship with age of the foetus. However, it is believed that the number of placentomes present would be sufficient to meet the nutritional and respiratory requirement of the foetus in a normal pregnancy.

In conclusion, this study has shown that the Fulani zebu placenta is synepitheliochorial with convex placentomes. The placenta size increases with gestation age in response to greater nutrient/metabolic requirement of the foetus, as the pregnancy progresses.

References


induced and spontaneous parturition as well as in cows retaining the fetal membranes. Reproduction 126: 469.


Reynolds LP, Biondini ME, Borowicz PP, Vonnahme KA, Caton JS, Grazul-Bilska, AT Redmer, DA (1990) Functional
significance of developmental changes in placental microvascular architecture. Endothelium 12: 11 – 19.


