Partial septate uterus and tubal implantation: a normal phenomenon in the *Eidolon helvum*

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The aim of the study was to investigate the macro and micro-anatomical adaptations in the uterus and the type and nature of implantation found in *Eidolon helvum*. A total of thirty pregnant bats sampled from Obafemi Awolowo University Campus were used in this study. They were harvested and sacrificed by cervical dislocation after being carefully assessed and confirmed to be presumably healthy. Abdominopelvic incisions were made on the bats to expose and excise their uteri. The uteri were observed macroscopically while some were fixed in 10% formal saline and processed for routine Haematoxylin and eosine (H&E) staining procedure and Verhoeff-van Giesson's stain. It was observed that the uterus of *E. helvum* possesses a partial septum that divides the uterine cavity into two compartments also; the lateral end of either of the uterine limbs was always enlarged or distended more than the other. As the dormant zygote began to develop in either of the uterine limbs, it grew lateromedially causing the particular limb to distend gradually towards the midline of the body. The uterine body did not participate in any way in carrying the developing fetus till term. Tubal implantation - a pathologic condition in some mammals was also observed to be natural in *E. helvum*. Thus, the presence of partial septate uterus and tubal implantation being a normal phenomenon in the *E. helvum* shows its primitiveness as a mammal.

**Key words:** Uterine limbs, uterine body, tubal implantation, partial septate uterus, *Eidolon helvum*.

**INTRODUCTION**

*Eidolon helvum* are fruit eating bats (Ogunbiyi and Okon, 1976; Okon, 1977) and exist in roosting colony at the Obafemi Awolowo University, Nigeria. Their natural posture (up-side-down) makes it a unique mammal (Kingdon, 1974; Okon, 1974). It is often recognized that reproductive periods of Frugivorous bats are closely linked to and may be triggered by peaks of fruit abundance (Bonaccorso, 1998; Dinerstein, 1986; Faria, 1995). They also exhibit the phenomenon of sperm storage and delayed fertilization and/or delayed implantation, sometimes due to alternation or intermittent periodic development of the male and female gonads per season. There is a delay in the implantation of the embryo in most, but not all, popula-
The uterus in mammals consists of a body, a base or fundus, a neck or cervix, and a mouth. The uterine body lies between the bases in the pelvis, it lies with the base directed upward and forward, and the cervix directed slightly backward. It is connected to the vagina by the cervix. On either side of the uterus lies an ovary (Heath et al., 2009). Eggs produced by the ovaries reach the uterus through the fallopian tubes. In the unimpregnated condition the uterus is about 7.6 cm (about 3 inch) in length, 5 cm (2 inch) in breadth, and 2.5 cm (1 inch) in thickness in *E. helvum* (Heath et al., 2009).

In pregnancy the fertilized egg implants itself in the lining of the uterus, where it grows to maturity; the walls of the uterus are elastic and stretch during pregnancy to hold the developing child. In mammals, when the Graafian follicle bursts, the egg falls toward the interior of the abdominal cavity. The oviduct (known in higher reproductive system to suit their reproductive life (Odukoya, 2008). We therefore set to verify the macro and micro-anatomical adaptations in the uterus and investigate the type and nature of implantation that the *E. helvum* has adopted to suit its reproductive life.

**MATERIALS AND METHODS**

**Care of animal**

A total of thirty pregnant bats (*E. helvum*) were sampled from the Obafemi Awolowo University Campus, Nigeria. The bats were identified in the Department of Zoology, Obafemi Awolowo University, Nigeria, and acclimatized for two weeks in the Animal Holdings of the Department of Anatomy and Cell Biology before sacrifice. The animals were fed with ripe bananas and water. The animals were physically assessed, screened and confirmed to be presumably healthy. All animals were treated in accordance with the “Guide for the Care and Use of Laboratory Animals” prepared by the National Academy of Sciences and published by the National Institutes of Health (1985).

**Excision of the abdominopelvic region**

The animals were sacrificed by cervical dislocation after pentobarbital administration. Abdominopelvic incisions were made to expose and excise their uteri (Figure 1). These uteri were immediately washed in physiological saline and blotted dry using filter paper. Some of the uteri were immediately fixed in 10% formal saline for histological analysis while others were studied macroscopically adopting a Celestron dissecting microscope.

**Histological procedures**

The harvested uteri were immediately fixed in 10% formol-saline limiting the post-mortem time to approximately 2 min. Tissues were fixed for a minimum period of 24 h before further processing. The tissues were dehydrated through graded alcohol and cleared in 3 changes of xylene (1.5 h each). Tissues were then infiltrated with molten paraffin wax at 56°C for 2 h each in 2 changes of paraffin wax. Embedding was done in paraffin wax for a period of 24 - 48 h. Sectioning was done at 5 µm thickness on a Rotary microtome and then subjected to Haematoxylin and eosine (H&E) staining procedure of Luna (1968) and Verhoeff-van Giesson’s stain.

**Figure 1.** Distended limb of the uterus after implantation, signifying the pregnant limb (PL). UB = Uterine Body; NPL = Non Pregnant Limb; and FT = Fallopian Tube. (X5).
RESULT

The uterus was bicornuate and symmetrical (Figure 1), but the internal arrangement observed was more of a partial septate type of uterus. It contains a septum attached to the body of the uterus in the uterine lumen anteroposteriorly, separating the uterine body into two lumina—right and left, which was continuous with the lumen of the corresponding uterine limbs (Figures 4 and 5). The septum is incomplete at the cranial end leaving a gap for communication between the lumina at the fundic region (Figures 6 and 7). Implantation was observed to be tubal in nature in the *E. helvum* (Figure 1). The histological arrangement of the uterus was in the following order from the inside out; the endometrium, the myome-

shown in Figures 4 and 5. A single lumen extended from the vagina, through the cervix to the inferior margin of the uterus where a septum was attached to the anterior and posterior walls of the uterine body dividing the uterine lumen into two, a right and left compartments as seen in Figure 2.

However, the septum was more or less an extension of the myometrium containing essentially the inner longitudinal and middle circular muscle fibres (Figures 4 and 5). The septum did not extend to the cranial and caudal margins of the uterine wall (the fundus and cervix respectively) permitting some degree of communication between the two uterine compartments and the uterine limbs, giving the terminal end of the septum a rounded, rod-like appearance (Figures 6 and 7).
DISCUSSION

We investigated the macro and micro-anatomical adaptations in the uterus and the type and nature of implantation the *E. helvum* has adopted to suit its reproductive life. The uterus in the *E. helvum* has been previously described as having an anteroposterior septum that separates the uterine body into a right and a left compartment (bicornuate), a description that fits into what could be described as septate uterus in agreement with Heinonen, (2006) and Perez-Brayfield et al. (2002).

Our investigation however revealed that the junction between the two uterine limbs and the uterine body, the septum is deficient that is; at the cranial end of the uterine body, leaving a communicating gap between the two uterine limbs, the terminal end having a rod-like rounded appearance. The same gap exists at the caudal end, making the cervical and vaginal passage thorough. This also fits into what could be described as a partial septate uterus (Heinonen, 2006; McNutty, 1996). The uterus in the *E. helvum* needs a more proper classification, considering the fact that it possesses a septum that partially divides the uterine cavity into two compartments as opposed to the description of a bicornuate uterus.

One lateral end of either of the two uterine limbs was always distended while the other was flattened out; this is suggestive of the delayed implantation phenomenon. It was apparent that the distended limb was the one that eventually carried the fetus to term, which could either be the right or the left uterine limb.

Tubal implantation referred to as ectopic pregnancy in advanced mammals which has very fatal anatomical and physiological implications appears to be a normal phenomenon in the Straw coloured fruit bat (*E. helvum*). The fetus implants in the uterine limb at its lateral extremity and gradually grows toward the uterine body along the medial path. The partial septate uterine body may have hormonal and metabolic contributions, but it did not participate in the carriage of the fetus during pregnancy. Histologically, the myometrium in the uterine limbs and body appeared very thick and compact in a non pregnant state. It was made up of smooth muscles interlaced with areolar tissues. The septum partially demarcating the uterus is an extension of the myometrium. The smooth muscles were well arranged, having an inner longitudinal, middle circular and outer circular and longitudinal outline (Cormack, 1997). Also, there was a mixture of elastic and collagen fibres but, the prevalent fibre was the elastic type. In the pregnant limb, collagen fibres are much more abundant as seen in Fig. 6 in conformity with earlier investigations (Cormack, 1997; Gulia et al., 2003; Jarret and Matthews, 1973). The non pregnant limb become highly vascularized with numerous glands (Figure 7) suggesting that it has a supporting role for the pregnant limb.

Conclusion

The histarchitecture of the uterus has been well elaborated and it is better classified as a partial septate uterus than a bicornuate type of uterus. Implantation in the uterine limbs is subject to a random natural selection or attached to a yet hidden cause. A comprehensive hormonal and ovarian investigation may hold more revealing answers to the cause(s) of the non specific preference in zygote implantation in the two uterine limbs. Thus, partial septate uterus and tubal implantation is a normal phenomenon in the *E. helvum*. All these observations indicate the primitiveness of the animal in agreement with Odukoya (2008).

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