Serial Ultrasonographic Evaluation of Postpartum Uterine Involution in Miniature Schnauzer Dogs

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ABSTRACT

This study was undertaken to determine the normal appearance of the postpartum uterine involution. Postpartum changes in uterine shape, architecture, echogenicity and diameter were monitored with ultrasonography in 8 Miniature Schnauzer dogs.

Vaginal discharge was observed visually during the 3 weeks of postpartum. A large amount of viscous dark green discharge changed progressively to a small amount of transparent discharge.

In the uterine shape, the transverse images were crescent or polygonal at the beginning, but became circular after 16 days. At postpartum day 24, the longitudinal images of placental and interplacental sites were similar to each other in size.

The echogenicity of uterine structure was clearly distinguishable among the hyperechoic serous membrane, hypochoic myometrium, hyperechoic endometrium, and anechoic uterine contents during the first week postpartum, but afterward the interluminal boundaries and echogenicity became obscure gradually. In addition, the anechoic substance of the endometrial cavity was not observed after postpartum day 28.

In the uterine diameter, the diameter of placental sites decreased markedly from 24 mm at the first day postpartum to 13 mm at day 7, and the diameter of interplacental sites decreased from 15 mm at postpartum day 1 to 10 mm at day 7. At postpartum day 65, the uterus (6.4 mm) changed little and had a uniform homogenous echo, and thus it was confirmed that uterine involution was completed at that time in Miniature Schnauzer dogs.

(Key words : ultrasonography, postpartum uterine, Miniature Schnauzer dogs)

INTRODUCTION

The normal involution of the canine postpartum uterus is visually completed in about 9 weeks and historically in about 12 weeks. Uterus discharge changes from reddish to brown, red and transparent gelatin over 4~6 weeks after the parturition and its amount decreases gradually (Reberg *et al.*, 1992; Watts *et al.*, 1997; Johnson, 2003). In addition, Grooters (2000) classified it into clinical involution and histological involution, and reported that clinical involution proceeds fast for 4~6 weeks and uterus discharge, namely lochia, takes place as a result of the restructuring of the placenta site. Johnson (2003) reported that a dark green vaginal discharge called uteroverdin comes out within 12 hours after the parturition and then red or reddish brown discharge comes out several times a day in mixture of cell fragments, mucous.

The delay of normal involution after the parturition is called subinvolution of placental site (SIPS) that is characterized by continuous vaginal discharge. Historically, bitches with SIPS are normal but vaginal discharge continues for several weeks postpartum (Al-Bassam *et al.*, 1981a).

Besides SIPS, there are other postpartum diseases accompanied with continuous discharge such as retained fetal membrane, postpartum uterine bleeding, damage to the reproductive organs, endometritis, pyometra and metritis (Dickie and Arbiter, 1993; Son *et al.*, 1996; Watts *et al.*, 1997; Grooters, 2000).

If there are uterine diseases or SIPS, the dog's estrous cycle is led to postpartum anestrus; and, if this problem continues, it may affect the next pregnancy (Al-Bassam *et al.*, 1981a; Concannon, 1989). Ferretti *et al.* (2000) reported that ultrasonographic examination is non-invasive and harmless to the specimen, allows easy observation of the uterus, and is the most accurate method for evaluating the uterus.

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Therefore, knowledge of the normal ultrasonographic appearance of uterine involution should be of clinical benefit in the management of postpartum bitches. The objective of the present study was to identify the normal postpartum uterine involution of Miniature Schnauzer, which is a common pet dog in Korea, by ultrasonographic evaluation.

MATERIALS AND METHODS

1. Animals

Serial ultrasonographic examinations were performed on 8 Miniature Schnauzer dogs. They were aged 1~3 years and weighed between 7.0~9.1 kg. Of the 8 dogs, 1 was primiparous and 7 were multiparous, having delivered twice or more. Before mating, an ultrasonographic examination was performed to check the normality of the reproductive organs. Before parturition, radiology tests were conducted to determine the litter size and the existence of fetal malformation, and 2 days before parturition, ultrasonographic examinations were conducted to inspect the survival of the fetuses.

2. Gross Examination

Until postpartum vaginal discharge was no longer observable, we visually observed the amount, color, viscosity and period of vaginal discharge everyday or twice a day.

3. Ultrasonographic Examination

Ultrasonographic examinations were performed for 100 days from parturition using LOGIQ 7 (GE Medical system, USA) mounted with 3.5, 7.0, 8.0 and 10.0 MHz probes. Before the ultrasonographic examination, the dogs were sheared entirely from the xiphoid cartilage to the pubic cartilage and the experimental dogs were placed in dorsal recumbency.

The interval of ultrasonographic examination was once in the first 7 days from the parturition (Day 0), every 3 days from day 8 to day 30, and once a week from day 31 to day 100. Uterine shape, the uterine echogenicity, the uterine wall thickness and the uterine diameter were determined.

All measurements were described in the unit of mm using the electronic caliper built in the ultrasonography machine.

1) The Uterine Shape

At each examination, one or more placental and interplacental sites along each uterine horn were imaged in the transverse section and the longitudinal section.

2) The Echogenicity and Thickness of Uterine Layers

The ultrasonographic image of the postpartum uterus consisted of a serous membrane, myometrium, endometrium, mucosa and contents. Each echogenicity was observed until placental site and interplacental site showed a homogenous echo and the diameter of each uterine layer was measured.

3) The Uterine Diameter

The uterine diameter was defined as the serosa to serosa measurements in placental and interplacental sites. For the accuracy of the measurement, the diameter of the transverse section was measured when the shape was the closest to a circle and the diameter of the longitudinal section was measured when it was the largest.

4. Statistical Analysis

All measurements were in mean ± standard deviation (SD) for the 8 mother dogs' postpartum uterine diameter, uterine wall thickness and time of completion of uterine involution.

RESULTS

1. Uterine Involution

In all the 8 Miniature Schnauzer dogs, the uterus involuted normally considering the period of visually observable vaginal discharge and the shape of the uterus, the echogenicity of uterine structure and the uterine diameter in ultrasonographic examination.

2. Normal Uterine Involution Process

1) The Period of Vaginal Discharge

A large amount of viscous dark green discharge was observed just after the parturition, dark brown discharge was observed in a week, and dark red discharge was observed 2 weeks postpartum. In addition, 3 weeks postpartum, the discharge became light and almost transparent in color and was mucous; and, at day 22.87±2.23 (Mean ± SD) postpartum, discharge was not observed any more.

2) The Uterine Shape

The ultrasonographic transverse image was crescent or polygonal until day 16.37±1.92 postpartum, but after that, it became circular. The postpartum shape of the uterus was beaded in shape, in which placental sites were larger than interplacental

sites in the longitudinal image after day 24.12±3.35 postpartum, it was tubular in shape, in which placental and interplacental sites were similar to each other in size (Table 1, Figs. 1 and 2).

3) The Echogenicity and Thickness of the Uterine Layers

In the echogram of the postpartum uterus, the outermost layer of the uterus was serosa, the innermost layer was mucosa, and the in between two layers were myometrium and endometrium.

Uterine serosa was distinctly hyperechoic, and the variation of its thickness was 1 mm from just after the parturition, showing no change until the completion of involution.

The myometrium was hypoechoic, and the thicknesses of placental and interplacental sites were 4.70±0.34 mm and 3.62±0.40 mm at day 1, and 3.33±0.24 mm and 2.09±0.32 mm at day 7, respectively, and decreased very slowly and became within 1 mm.

The endometrium was more hyperchoic than the myometrium and placental sites was more hypoechoic than the interplacental sites. The thicknesses of placental and interplacental sites were 8.80±0.16 mm and 4.34±0.46 mm at day 1, and 3.63±0.42 mm and 2.82±0.19 mm at day 7, respectively, showing

Table 1. Characteristic changes of postpartum uterus in the transverse plane and longitudinal plane using ultrasonography in 8 Miniature Schnauzer dogs

Uterine shape	Days (Mean±SD)
Circular shape (in the transverse plane)	16.37±1.92
Tubular shape (in the longitudinal plane)	24.12±3.35

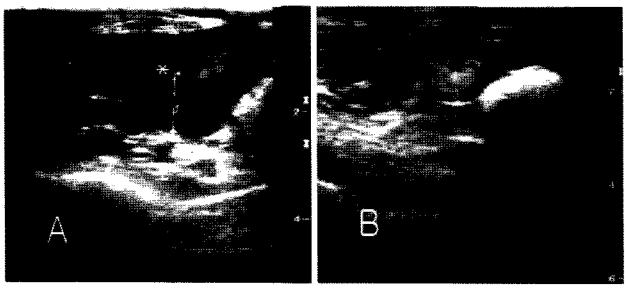

Fig. 1. Ultrasonograms of the uterus in the transverse plane at day 2 (A) and day 14 (B) postpartum. 10.0 MHz linear probe. (A) Uterine fluid detected as a focal anechoic area (*) in the uterine cavity of placental site and uterine horn appeared to be polygonal shape.(B) Uterine horn appeared to be circular shape.

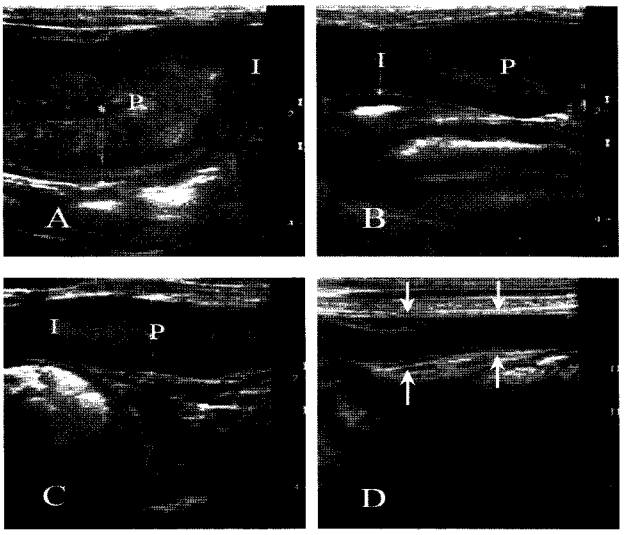

Fig. 2. Ultrasonograms of the uterus in the longitudinal plane at day 2 (A), day 7 (B), day 21 (C), and day 65 (D) postpartum. 10.0 MHz linear probe. I: interplacental site, P: placental site, white arrow: serosa of uterine, *: uterine contents.

that uterine involution in placental sites was faster than interplacental sites.

Uterine mucosa was hyperechoic, and the contents of the uterus was anechoic. Until the completion of the involution of the postpartum uterus, the variation of the thickness of mucosa was less than 1mm but the thickness of mucosa was not consistent because of the contents of the uterus. Uterine content was detected from parturition to day 28.25±4.20. As the contents of the uterus decreased, the capacity of the uterus decreased, and, as a result, the mucosa contracted around the uterine lumen, and the mucosa became adjacent to each other.

The interluminal boundaries and echogenecity were distinct during the first 7 days postpartum, but they became indistinguishable after day 7.

4) The Uterine Diameter

Table 2 and Fig. 3 represent changes in placental sites and the diameter of the postpartum uterus. The diameter of placental sites was 24.06±1.98 mm at day 1 and 13.31±1.42 mm at day 7, showing a marked decrease, and the diameter of interplacental sites decreased from 14.72±1.78 mm at day 1 to 9.99±0.76 mm at day 7. At postpartum day 37, the diameters of placental and interplacental sites were 7.18±0.34 mm and 6.70±0.16 mm, respectively, showing only a small difference between them. Afterward, the diameters of placental and interplacental sites

Table 2. Uterine diameter of placental and interplacental sites using ultrasonography in 8 Miniature Schnauzer dogs (Mean±SD)

Days postpartum	Placental sites (mm)	Interplacental sites (mm)
1	24.06±1.98	14.72±1.78
7	13.31±1.42	9.99±0.76
37	7.18±0.34	6.70±0.16
65	6.41±0.19	6.41±0.22

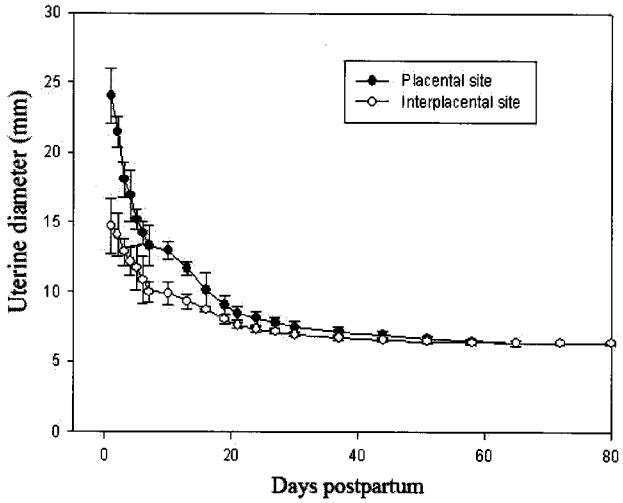

Fig. 3. Average of uterine diameter at placental and interplacental sites using ultrasonography in 8 Miniature Schnauzer dogs (Mean±SD).

decreased slowly, becoming 6.41±0.19 mm and 6.41±0.22 mm, respectively, at day 65 and from that time on there was little change in the diameter of the uterus.

5) Completion of Uterine Involution

Uterine involution was completed in 65±8 days postpartum, and at that time the diameter of the uterus was 6~7 mm and the uterine structure was uniform with homogenous echo (Fig. 2D).

DISCUSSION

Early detection of periparturient disorders is important, and may save the life of the bitch and pups. Periparturient disorders include a wide variety of diseases, ranging from those that resolve without medical or surgical treatment to those that are life threatening and require vigorous therapy to ensure a positive outcome for the bitch and pups. The peripartum period extends from late gestation through several weeks after parturition. The postpartum period refers to the period following parturition (Johnston *et al.*, 2001).

One of these disorders, SIPS occurs when the involution process is delayed. In normal bitches without SIPS, fetal trophoblasts or maternal decidual cells can be observed in the upper connective tissue of the lamina propria for the first 2 weeks after whelping (Al-Bassam *et al.*, 1981a). However, in bitches with SIPS, these throphoblastic cells do not degenerate and continue to invade the deep glandular layer of the endometrium or even the myometrium. This trophoblastic invasion, concomitant vascular damage to blood vessels, and failure of normal endometrial blood vessel thrombus formation and secondary occlusion are proposed as potential causes of SIPS in dogs. Historically, bitches with SIPS are normal except for a hemorrhagic uterine discharge that passes from the vulva for several weeks postpartum (Johnston, 1986). The amount of blood passing may range from a few drops each day that subside without therapy to acute, life-threatening hemorrhage that requires transfusions and immediate surgical intervention. In chronic cases, the uterine discharge may pass for 8 weeks or even until the next proestrus onset. SIPS has been diagnosed histologically as late as 9 weeks postpartum in a clinically normal bitch undergoing elective ovariohysterectomy (Dickie and Arbeiter, 1993).

For the diagnosis of periparturient disorders like SIPS, ultrasonography is very useful for imaging the internal structures of the uterus. Therefore, ultrasonography allows visualization of intraluminal contents and uterine wall characteristics after parturition.

All the 8 Miniature Schnauzer dogs of the present study had the normal uterine involution process through gross examination and ultrasonographic examination. The morphological characteristics of postpartum uterine involution represent serial changes in the ultraosonographic appearance. The transverse image of placental sites were observed polygonal after parturition and then it became circular at postpartum day 16. During 24 days postpartum, the beaded shape of uterus gradually changed to a tubular structure in the longitudinal image. The changes of the postpartum uterus is similar to several reports (Yeager and Concannon, 1990; Son *et al.*, 1999; Son *et al.*, 2001; Oh *et al.*, 2005; Hwang *et al.*, 2005). It is due to marked contraction of placental sites compared to interplacental sites.

The postpartum uterus consisted of 5 echogenically distinct layers in the ultrasonographic image, that represented serosa, myometrium, endometrium, uterine contents and mucosa (Son *et al.*, 1999; Son *et al.*, 2001; Oh *et al.*, 2005; Hwang *et al.*, 2005). The interluminal boundaries were distinct during the first 7 days postpartum, but they became indistinguishable because of the rapid decrease of myometrium (4.70 to 3.33 mm) and endometrium (8.80 to 3.63 mm) (Al-Bassam *et al.*, 1981b; Yeager and Concannon, 1990; Reberg *et al.*, 1992), but this is different from the report of Son *et al.* (2001) where, in small-size pet dogs, interluminal boundaries were clear until day 16 postpartum.

As to the uterine diameter, during the first week postpartum, there was a significantly larger decrease in placental sites (24.06 to 13.31 mm) than in interplacental sites (14.72 to 9.99 mm) (Table 2, Fig. 3). Possible reasons for the decrease are the discharge of uterine contents and the decrease of myometrium and endometrium (Yeager and Concannon, 1990; Son *et al.*, 1999; Oh *et al.*, 2005; Hwang *et al.*, 2005).

As presented above, in the Miniature Schnauzer dogs, postpartum vaginal discharge was observed during the first 3 weeks postpartum, the uterine shape changed from bead-shape to tubular at day 24 postpartum, and the diameter of the uterus was 6.50～7.82 mm at day 37 postpartum and about 6 mm at day 65 and almost constant afterward, showing homogenous texture, which suggested that uterine involution completed at that time. This is similar to 65 days and 68 days postpartum reported, respectively, by Oh *et al.* (2005) and Hwang *et al.* (2005) on their research with Shih-tzus and Cocker spaniels dogs, respectively, but somewhat different from 12～13 weeks in the research by Yeager and Concannon (1990) with beagles, 80～94 days in the research by Son *et al.* (1999) with Jin-do dogs, and 94 days in the research by Son *et al.* (2001) with Yorkshire terriers and Malteses dogs. The differences of time in postpartum uterine involution may not be caused by dog breeds, but by parity and technical factors like the operator's skills and ultrasonographic equipment.

In summary, in Miniature Schnauzer dogs, the completion of postpartum uterine involution took about 65 days. The uterine shape, the echogenicity and thickness of uterine layers, and uterine diameter in ultrasonographic examination were generally consistent between dog breeds. Therefore, ultrasonography is a useful method of detecting structural abnormalities in the postpartum uterus and of determining completion of normal uterine involution in the dog.

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