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Gross Anatomical Characterization of Jejunal and Ileal Peyer's Patches in Japanese Black Calves

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ABSTRACT

Cattle have two types of morphologically and functionally different Peyer's Patches (PP): ileal PP and jejunal PP. The small intestines of Japanese black calves were cut and opened along the mesenteric attachment site. The distribution, length and number of ileal PP and jejunal PP were examined by gross-anatomical observation. Ileal PP was observed as single continuous aggregations of lymphatic follicles extending cranially from the ileal opening. The length of the ileal PP was approximately 12% of the small intestine. Jejunal PP were observed as multiple and discrete accumulations of lymphatic follicles. The number and total length of jejunal PP were approximately 30 and 10% of the length of the small intestine, respectively and were similar to those reported for other ruminants. The localization of jejunal PP was observed throughout the small intestine with many (20-40%) distributed in the anterior part of the small intestine.

Key words: Japanese black calf, jejunal Peyer's patch, ileal Peyer's patch, Peyer patch number, localization, gross anatomy

INTRODUCTION

Cattle, sheep and goat intestines contain two types of Peyer's Patches (PP), ileal and jejunal PP, each having morphological and functional differences (Griebel and Hein, 1996; Reynolds and Morris, 1983; Yasuda *et al.*, 2006). Ileal PP are thought to be a primary lymphoid organ for B-cells and are composed of long elliptical lymphatic follicles densely packed with narrow interfollicular T cell areas. Jejunal PP are thought to be a secondary lymphoid organ for local immunity and are composed of lymphatic follicles that are more widely dispersed and associated with larger interfollicular T cell areas than those of ileal PP (Gerber *et al.*, 1986; Hein *et al.*, 1989; Yasuda *et al.*, 2004). Ileal PP and jejunal PP develop prenatally, but ileal PP involute after reaching their maximum size early in life whereas jejunal PP persist for the animal's life (Reynolds and Morris, 1983; Yasuda *et al.*, 2004, 2006). There are many mucosal infectious diseases in calves such as bacteria, virus and protozoa infection (Vermunt and Parkinson, 2000; Walz *et al.*, 2010). PP has a important role of mucosal immunology for preventing these infectious diseases. Bovine PP have been extensively examined in histological and immunological studies (Griebel and Hein, 1996; Yasuda *et al.*, 2006) but gross anatomical evaluation of PP such as the number, localization and length that they occupy in the small intestines of Japanese Black (JB) calves has not yet been reported. The purpose of this study was to gather information about the jejunal and ileal PP of JB calves through gross anatomical observations.

MATERIALS AND METHODS

Animals: JB calves (n = 21; 11 males and 10 females; 1-8 months old) were obtained from a local farm in Miyazaki Prefecture from 2010 to 2011 year. The animals were killed by electric shock following intravenous injection with a combination of xylazine (0.2 mg kg^{-1}) and pentobarbital (15 mg kg^{-1}). All animal procedures were approved by the Institutional Animal Care and Use Committee of the University of Miyazaki.

Gross-anatomical observation and collection of specimens: The small intestines were cut and opened along the mesenteric attachment site to examine the distribution, length and number of PP. The mucosal surface was rinsed gently with 0.01 M phosphate-buffered saline (pH 7.2) to remove the intestinal contents. The suspected small intestine lymphoid tissue was verified by histological observation using HE staining.

Statistical analysis: The statistical analysis consisted of an Analysis of Variance (ANOVA) and multiple comparison tests performed with ANOVA4. The p-values <0.05 were regarded as statistically significant.

RESULTS

The small intestines of 1 to 8 months old JB calves were used in this study. In some cases, jejunal and ileal PP could be recognized from the serosa side of small intestinal wall. However, identification of the number, length and localization of jejunal and ileal PP from the mucosal side was much easier than that of the serosa side. Therefore, in all specimens, a single continuous ileal PP and multiple dispersed jejunal PP were confirmed by gross anatomical observation from mucosal side of the small intestine after washing PBS (Fig. 1). The small intestines of JB calves, consisting

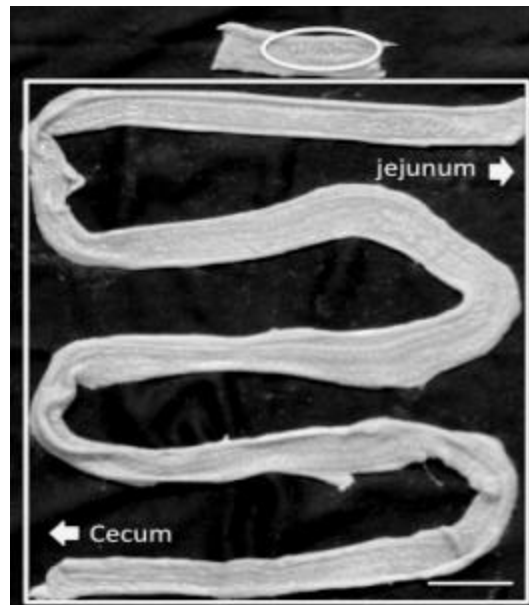


Fig. 1: Gross anatomical aspect of the ileal PP in a Japanese black calf at 1 month of age. The photo shows the mucosal site of the small intestine from the ileal opening to the proximal site, which is approximately 4 m. The full length of the ileal PP and one of the jejunal PP are surrounded by a rectangle and a circle, respectively. Scale bar = 10 cm

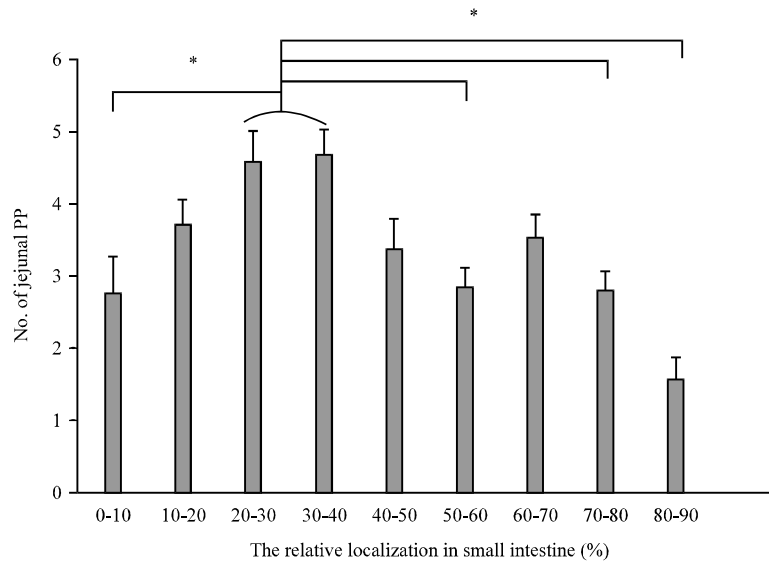


Fig. 2: The number and localization of jejunal PP in the small intestine of Japanese black calf. Ileal PP located in about 90-100% region in the small intestine, *Significant difference ($p < 0.05$)

of the cranial part of the duodenum to the ileal opening, measured 1955.0 ± 119.6 cm (Mean $\pm$ SE). The length of the ileal PP reached $11.5 \pm 0.6\%$ of the length of the small intestine. The total length of the jejunal PP was $9.5 \pm 0.4\%$ of the length of the small intestine. There were 29.9 ± 1.4 jejunal PP in the small intestine. Jejunal PP were observed throughout the small intestine but the number of jejunal PP in 20-40% areas was significantly higher than other areas of the small intestine as described in Fig. 2. There were no differences in the number, localization or length of the PP in the small intestines of male and female JB calves (data not shown).

DISCUSSION

Single ileal PP and multiple jejunal PP have been reported in sheep, cattle, goats, pigs and dogs, although the number of jejunal PP is different between the species (Griebel and Hein, 1996). Ileal PP are a primary lymphoid organ for B cells, while jejunal PP are a secondary lymphoid organ that plays a role in the development of local immune responses (Larsen and Landsverk, 1986; Mutwiri *et al.*, 1999; Yasuda *et al.*, 2006). The mean length of JB calf ileal PP was about 11.5% of the length of the small intestine, which was similar to that in other ruminants (Griebel and Hein, 1996; Kikukawa *et al.*, 2012). The number of jejunal PP was also similar in ruminants (25-40) and pigs (14-27) (Griebel and Hein, 1996). This study evaluated the total length of both types of PP in the small intestine. The mean ratios of the lengths were about 11.5% (ileal PP) and 9.5% (jejunal PP) of the small intestine. There was no significant difference between the lengths of the jejunal and ileal PP, but localization of both PP in the small intestine differed considerably. The lymphoid tissues of ileal PP formed in most areas of the lamina propria and the submucosal area of the ileum except for the mesenteric border. However, the tissues of jejunal PP were generally oval or rectangular in shape and situated on the anti-mesenteric border. Therefore, the proportion of jejunal PP to the total PP was about 10-20% (Griebel and Hein, 1996). The number of jejunal PP in the anterior part of the small intestine (especially 20-40% was significantly higher than in

other parts of the small intestine. It has been reported that IgM⁺ cells are increased in the primordial jejunal PP that are located in the anterior part of the small intestine during middle fetal development (Alitheen *et al.*, 2003). B cell migration waves into the small intestine during fetal development might affect the localization of developing jejunal PP. In addition, after involution of ileal PP, jejunal PP types tissue formed in the ileum (Lie *et al.*, 2005).

CONCLUSION

The number and localization of Japanese Black calf ileal and jejunal PP are very similar to those of other ruminant PP. In addition, it needs further analysis of cattle PP proportion in small intestine after involution of ileal PP.

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