

MORPHOLOGICAL STUDIES OF THE PEYER'S PATCHES OF THE GOAT (*Capra hircus*). I. GROSS CHANGES WITH AGE.

R. J. Assey *Department of Veterinary Anatomy, Sokoine University of Agriculture, P. O. Box 3016, MOROGORO TANZANIA.*

SUMMARY

Gross morphological studies were performed on the Peyer's patches of three age groups of local breed male goats. Neonatal kids had an average of 35 Peyer's patches in the jejunum, two in the colon and a long patch which extended from the jejunum to the ileocecolic junction (jejuno-ileal Peyer's patch JIPP). There were no patches in the duodenum. The JIPP atrophy with age. There was no significant difference ($P > 0.05$) between the number of Peyer's patches in the three groups. The proportion of intestine on which the Peyer's patches extended in both neonatal and three months old kids was significantly higher ($P < 0.05$) than that of 12 months old goats. The JIPP showed morphological similarities to a primary lymphoid organ.

INTRODUCTION

Peyer's patches are organized lymphoid tissues in the intestinal tract which have more than five follicles (Doughri *et al.*, 1972). They are found in the laboratory animals (Titkemeyer and Calhoun, 1955; Hood *et al.*, 1978; Burns, 1982). Similar organized lymphoid tissue at the cloaca of the birds is the Bursa Fabricii.

The avian Bursa of Fabricius is a primary lymphoid organ which is essential in the differentiation and maturation of the B-lymphocytes (Cooper *et al.*, 1966; Ivanyi *et al.*, 1972; Fitzsimmons *et al.*, 1973; Baba *et al.*, 1981). Postnatally, the population of B-lymphocytes in mammals originate in the bone marrow (Roitt, 1977). However, Peyer's patches in pigs, sheep and calves have been shown to have some developmental, morphological and function similarities to the avian Bursa of Fabricius (Chapman *et al.*, 1974; Muller-Schoop and Good, 1975; Reynolds *et al.*, 1981; Reynolds and Morris, 1983; Landsverk, 1984; Miyasaka *et al.*, 1984; Reynolds and Morris, 1984). Nevertheless, evidence has been presented for the

existence of two distinct types of Peyer's patches in sheep (Reynolds, 1980; Reynolds *et al.*, 1981; Reynolds and Morris, 1983; Miyasaka *et al.*, 1984).

Division of lymphoid organs into central (primary) or peripheral (secondary) is generally based on a number of non immunological criteria amongst which are stage of development at birth and morphological changes with age (Faulk *et al.*, 1971).

Much of the research on the Peyer's patches has been done in mice, rabbits, pigs and sheep. Similar studies must be done in other mammals as well in order to understand the role of the Peyer's patches in the immune system. The caprine is an important source of meat in the world today and it is also becoming useful in biomedical studies.

In this study, gross morphological investigations of the Peyer's patches in three age groups of conventionally reared Tanzania local breed male goats

were performed.

MATERIAL AND METHODS

The groups consisted of ten about 12 hours old kids (neonates) which had not suckled weighing 1.9 ± 0.3 kg (mean \pm standard deviation), 15 about three months old kids weighing 5.0 ± 1.3 kg and 15 about twelve months old goats weighing 20.5 ± 2.9 kg. The age of the latter two groups was obtained from records or was estimated according to Holst and Denney (1980) and Schummer *et. al.*, 1979).

Animals of the first groups were killed by exsanguination through the jugular veins after anaesthesia. Specimens from the 12 months old goats were collected from an abattoir.

Immediately after death, the animals were weighed and within five minutes, the gastrointestinal tract was removed *en masse* and thorough postmortem inspection done. Animals showing antemortem or postmortem lesions were excluded from the study.

The liver, spleen, omenta and the stomach compartments were dissected out. The latter were weighed and their weight subtracted from the weight of the animal after bleeding to obtain the corrected body weight. This was necessary as there was no control over feeding of the 12 months age group. Intestine levels were then marked from the cardia according to established boundaries.

The mesenteries were dissected out and intestine levels lengths were measured and recorded. The intestines were processed for gross measurements of the Peyer's patches according to Cornes (1965). Peyer's patches at each level were counted and individual lengths measured. A magnifier was sometimes used for counting the follicles and an

aggregation of five or more follicles was counted as a Peyer's patch.

All numerical results were analysed for means and standard deviations. Correlation analyses were performed between length of intestine and total length of Peyer's patches. Student's t-test was used to test the significance of the statistical results.

RESULTS

Neonatal kids had an average of 35 Peyer's patches in the jejunum which had a total length of 0.9 ± 0.1 m. They ranged in size from five follicles to 4.5cm. long patches which were oval or elongate with round ends. In addition to these a Peyer's patch which measured about 0.8 m in length extended from the jejunum to the ileocecolic junction (jejuno-ileal Peyer's patch - JIPP). Its caudal one-third was wider than the cranial two-thirds. The colon had two round patches (Colon Peyer's patches CPP), which were always located in the proximal portion of the ascending colon. Neither the duodenum nor the caecum had any patches. The patches extended along 17.0 ± 1.6 % of the intestine length.

At three months age, there was an average of 38 Peyer's patches in the jejunum (JPP) which ranged in size from five follicles to 5.4 cm. long patches, and had a total length of 1.5 ± 0.3 m. The JIPP measured 1.4 ± 0.2 m and was not uniformly wide (Fig. 1). The colon had two round or cone shaped patches which were always located in the proximal portion of the ascending colon (Fig.2). There was a single observation of a Peyer's patch in the caecum. The Peyer's patches extended along 18.0 ± 2.4 % of the intestine length.

There was an average of 33 Peyer's patches in the jejunum with individual patches of up to 8.1 cm. length in the

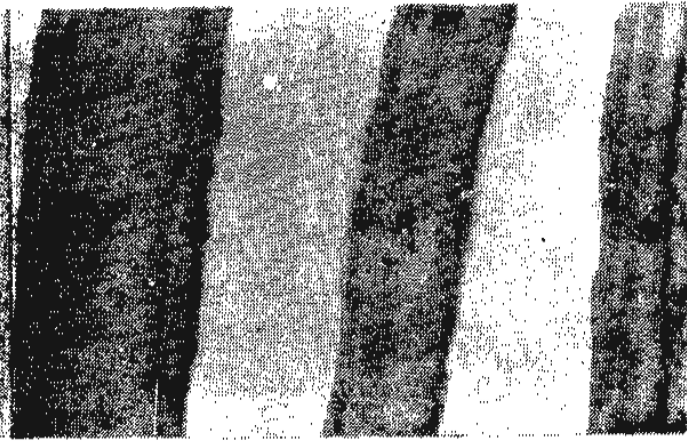


Figure 1: JIPP from a 3 months old kids. Caudal one third (P) is wider than the middle (R) and cranial (S) portions.

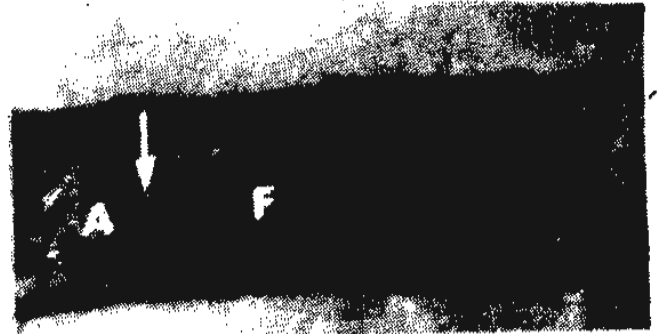


Figure 3: Cranial end of a JIPP from a 12 months old goat. Note border (arrow) of grossly visible follicular part (F) and the atrophied part (A).

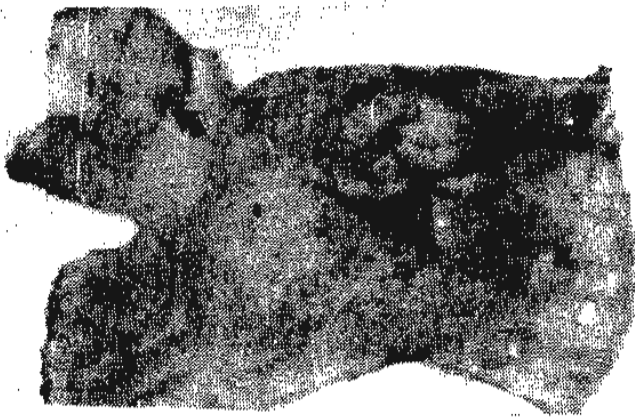


Figure 2: A colic Peyer's patch from a 3 months old kid. Note the termination of the JIPP (arrow). C, cecum; K, colon; I, ileum.

12 months old goats. The JIPP had grossly atrophied (Fig. 3). Two patches were observed in the colon. The Peyer's patches extended along $12.7 \pm 1.9\%$ of the intestine length.

The mean total length of the intestine and Peyer's patches increased at a relatively higher rate to three months of age, but at a lower rate to the 12 months of age.

The mean proportion of the intestine on which the Peyer's patches extended increased to the three months age group where it reached a peak and decreased thereafter (Table 1). There was a significant difference ($P < 0.05$) between the means of the proportion of intestine covered by Peyer's patches in the neonatal and the 12 months old goats, and between the three months old kids and the 12 months old goats. There was no significant difference ($P > 0.05$) between the proportion of intestine covered by Peyer's patches in the neonate and three months old kids. There was also no significant difference ($P > 0.05$) between the number of the Peyer's patches in the three groups.

Within the age groups, there was no significant correlation ($P > 0.05$) between intestine and Peyer's patches lengths.

Table 1: Mean lengths of intestine and Peyer's patch (m) in neonatal, 3 months and 12 months old goats (Mean \pm standard deviation).

Age	Total length of intestine (excluding rectum)	Total length of Peyer's patches	% of intestine length covered by Peyer's patches.
Neonates (n=10)	7.33 \pm 0.44	1.23 \pm 0.12	17.0 \pm 1.6
3Months old (n=15)	11.84 \pm 1.43	2.11 \pm 0.25	18.0 \pm 2.4
12Months old (n=15)	19.63 \pm 2.99	2.49 \pm 0.52	12.7 \pm 1.9

DISCUSSION

Neonatal kids had an average of 35 Peyer's patches in the jejunum and about 17% of the intestinal length was covered by Peyer's patches. These are within the range reported in lambs (Reynolds and Morris, 1983). Similar to findings in lambs and piglets (Reynolds and Morris, 1984; Chu *et al.*, 1979a,b) a long patch extending from the jejunum to the ileocecolic junction was found. Reynolds and Morris (1983) termed it ileocecal Peyer's patch (IPP) but to show its anatomical extent the term, Jejuno-Ileal Peyer's patch (JIPP) is used here. There is no report in other species of occurrence of Peyer's patches in the colon, but in this study an average of two were observed. Similar to findings in sheep and rabbits (Titkemeyer and Calhoun, 1955; Cornes, 1965) no patches were found in the duodenum.

Kids were killed about 12 hours after birth. There is little doubt therefore, that the grossly visible Peyer's patches were formed during prenatal period similar to the thymus and the

Bursa of Fabricius which are primary lymphoid organs. The nature of the caprine placenta which is of epitheliochorial type (partly syndesmochorial) makes the environment in which the foetus develops antigen-free, both from exterogenic antigens and from maternal antibodies (Brambell, 1970). Therefore, development of the grossly visible Peyer's patches in the neonatal kids most likely had occurred in the absence of antigenic stimulus. However, there could be autogenous enterogenic antigens, but these have not been shown to exist at least in the sheep which have same type of placenta and equal gestation period as the goat. Factors other than antigens therefore, could have caused the lymphopoiesis in the Peyer's patches in the kids in a similar manner as in the lambs patches and avian Bursa of Fabricius (Lydyard *et al.*, 1976; Moore and Owen, 1966; Reynolds and Morris, 1983; 1984).

The mean number of Peyer's patches of the three age groups did not differ significantly ($P > 0.05$). However, the size

of the individual patches seems to increase with age. This is most probably a reflection of the absolute increase in size (both length and diameter) of the gut. In man, there is a tendency for the number of Peyer's patches to increase in size and number with age to puberty after which there is a decrease (Cornes, 1965). Nevertheless, the mean number of patches observed in this study was higher than that reported by Titkemeyer and Calhonun (1955). This may be due to the fact that the latter authors did not process the intestines, something which was done here. The processing in acetic acid followed by staining with polychrome methylene blue makes the follicles more apparent and thus easier to count. The significantly higher proportion of intestine of which the Peyer's patches extended in both neonates and three months old kids compare to that of 12 months old goats reflects that, the intestinal tract may be better protected from birth to three months age than later. At 12 months of age, the macroscopic evidence of the JIPP was on the disappearance. The gross atrophy was supported by histological observation (to be reported in part II). The JPP and CPP did not show signs of atrophy. The caprine therefore have two types of Peyer's patches as the sheep (Reynold, 1980; Reynolds et al., 1981; Reynolds and Morris, 1983; Miyasaka et al., 1984). The JIPP as is the IPP of sheep (Reynolds and Morris 1983) show morphological resemblance to a primary lymphoid organ.

ACKNOWLEDGEMENT

The author wishes to thank Professors Per Kjaersgaard and Nils Bjorkman for supervision and DANIDA for financing the project.

REFERENCES

- Baba, T., K. Nakahara, T. Sugano and T. Tanaka (1981). Effect of bursal perfusate on IgG antibody production in incomplete surgically and hormonally bursectomized chickens. *Res. Vet. Sci.* 31: 5 - 9.
- Brambell F.W.R. (1970). Transmission of immunity in the ruminants. *Frontiers of Biology, North - Holland Res. Monographs* 18: 201 - 233.
- Burns, R.B. (1982). Histology and immunology of Peyer's patches in fowl (*domesticus*). *Res. Vet. Sci.* 32: 359-367.
- Chapman, H.A., J.S. Johnson and M.D. Cooper (1972). Ontogeny of Peyer's patches and immunoglobulin - containing cells in pigs. *J. Immun.* 112: 555 - 563.
- Chu, R.M., R.D. Glock and R.F. Ross (1979a). Gut-associated lymphoid tissues of young swine with emphasis on dome epithelium of aggregated lymphoid nodules (Peyer's patches) of the small intestine. *Amer. J. Vet. Res.* 40: 1720 - 1428.
- Chu, R.M., R.D. Glock, R.F. Ross and D.F. Cox (1979b). Lymphoid tissues of the small intestine of swine from birth to one month of age. *Amer. J. Vet. Res.* 40 1713 - 1719.
- Cooper, M.D., D.Y. Perey, M.F. McKneally, A.E. Gabrielsen, D.E.R. Sutherland and R.A. Good (1986). A mammalian equivalent of the avian Bursa of Fabric. *The Lancet* 1: 1388 - 1391.

- Cornes, J.S. - (1965). Number, size and distribution of Peyer's patches in the human small intestine. *Gut* 225 - 229.
- Doughri, A.M., K.P. Altera and R.A. Kainer (1972). Some developmental aspects of the Bovine fetal gut. *Anat. Hist. Embry. A.* 19: 417 - 434.
- Faulk, W.P., J.N. McCormick, J.R. Goodman, J.M. Yoffey and H.H. Fudenberg (1971). Peyer's patches: Morphologic studies. *Cell. Immun.* 1: 500 - 520.
- Fitzsimons, E.C., E.M.F. Garrod and Garnett (1973). Immunological responses following early embryonic surgical bursectomy. *Cell. Immun.* 9: 377 - 383.
- Habel, R.E. (1975). Guide to the dissection of Domestic Ruminants. 3rd. edition. Robert E. Habel. Ithaca New York. pg. 29.
- Holst, P.J. and G.D. Denney (1980). The value of dentition for determining the age of goats. *Int. Goat and Sheep Res.* 1: 41 - 47.
- Hood, L.E., I.L. Weissman and W.B. Wood (1978). Immunology. The Benjamin/Cummings Publishing Company, Inc. menlo Park, Cal., Reading, Mass, Lond., Amster., DonNills, Ont., Syd. Chapter 1 pp. 1- 155.
- Ivanyi, J., L.B. Murgatroyd and P.M. Lydyard (1972). Bursal origin of bone-marrow cells with competence for antibody formation. *Immun.* 23:107-111.
- Landsverk, T. (1984). Is the Ileocecal Peyer's patch in Ruminants a mammalian 'Bursa equivalent'? *Acta Path. Micr. Scand. A* 92:77-79.
- Lydyard, P.M., C.E. Grossi and J.D. Cooper (1976). Ontogeny of B-cells in the chicken. I. Sequential development of clonal diversity in the Bursa. *J. Exp. Med.* 144:79-97.
- Miyasaka, M.L. Dudler, G. Bordman, W.N. Leiserson, H.A. Gerber, J.Reynolds and Z.Trnka (1984). Differentiation of B-lymphocytes in sheep. I. Phenotypic analysis of Ileal Peyer's patches cells and the demonstration of a precursor population for sig cells in the Ileal Peyer's patches. *Immun.* 53: 515-523.
- Moore, M.A.S. and J.J.T. Owen (1966). Experimental studies on the developmental of the Bursa of Fabricius. *Dev. Biol.* 14: 40-51.
- Muller-Schoop, J.W. and R.A. Good (1975). Functional studies of Peyer's patches. Evidence for their participation in intestinal immune responses. *J. Immun.* 114: 1757-1760.
- Reynolds, J.D. (1980). Gut-associated lymphoid tissues in lambs before and after birth. *Monogr. Allergy* 16:187-202.
- Reynolds J.D. and B. Morris (1983). The evolution and involution of Peyer's patches in foetal and post-natal sheep. *Eur. J. Immun.* 13: 627-635.
- Reynolds, J.D. and B. Morris (1984). The effect of antigen on the development of Peyer's patches in Sheep. *Eur.J.Immun.* 14:1-6.

Reynolds, J.D., R.N.P. Cahill and Z. Trnka (1981). Peyer's patches as a 'Bursa equivalent'. A new look at some old arguments. Proceedings of the first Congress of Developmental and Comparative Immunology. ed. J.B. Solomon. Abardeen, Oxford, U.K. Pergamon Press Ltd. pp. 265-272.

Roitt, I.N. (1977). Essential Immunology. ELBS and Blackwell Scientific Publications. Oxford. Lond. Edin. pp. 47-100.

Schummer, A., R. Nickel and W.O. Sac (1979). The Viscera of th Domestic Mammals. 2nd editor Verlag Paul Parey, Berlin Hamburg. pp.133-171.

Titkemeyer, C.W. and M.L. Calhoun (1955). A comparative study o the structure of the smal intestines of Domestic Animals Amer. J. Vet. Res. 16: 152-157