

THE MORPHOGENESIS OF THE SMALL INTESTINAL MUCOSA OF THE RABBIT
A STEREOMICROSCOPICAL STUDY

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Introduction

One way of studying the intestinal mucosa in disease or under experimental conditions is a stereomicroscopical evaluation of the surface (Kapadia and Baker, 1976; Mouwen, 1972). To be able to form an opinion concerning pathological changes, it is necessary to have insight in the normal structures. For this reason the development of the villous structure of the rabbit small intestine was studied in clinically normal rabbits during the first 10 weeks of their lives.

This study forms a base for studying the possible role of lectins (in this case soy-lectins) in the enteropathy-complex of rabbits (Sanchez, 1985).

Materials and methods

Animals:

Two groups of 10 pregnant New Zealand White rabbits were obtained from a commercial rabbitry. The animals were housed individually. Group I was given a feed containing 20% soy roughage as the source of protein, while group II received a feed with 16% animal proteins. Both feeds were identical in energy and in the amount of crude fiber.

All the does delivered their young within a period of 48 hours (mean number per litter was eight). In the third week after birth, when the young started taking solid food, they were given the same diet as their mothers. The animals were weaned in the fifth week after birth.

Once a week, starting on the second day after birth, six clinically healthy young rabbits were taken out of six different litters, evenly distributed over the nests, in such a way that the litter sizes remained comparable. Three rabbits were chosen from group I and three from group II. This procedure was repeated until the rabbits were ten weeks old.

Sampling:

The animals were weighed and anaesthetised (ketamine HCl: 100 mg/kg, xylazine HCl: 20 mg/kg, atropine: 0,1 mg/kg, intramuscularly). The abdomen was opened in the midline and the small intestines were removed. The length of duodenum, jejunum and ileum was measured. The intestines were opened and the contents were carefully flushed away with a 0.9% saline solution. From the middle of each intestinal section a sample was taken of approximately two cm long, which was pinned on a dental wax plate. The samples were then fixed in 4% neutral buffered formaldehyde.

The animals were euthanised by an intravenous injection of Na-pentobarbital; autopsy was performed. Four animals appeared to suffer from pneumonia and were excluded from the study.

Examination of the samples:

To examine the villous structures the formaline fixed pieces of tissue were immersed in water in a Petridish. The dish was placed under a stereomicroscope (Wild M5A) and the villous forms were evaluated with a 60x magnification.

The different villous forms were graded from 1 to 5 in analogy to work of Mouwen (1972, Fig.1).

Of some specimens that were good examples of the different stadia of the development, scanning electronmicroscopical images were made.

The mucosa overlying Peyers patches was not evaluated.

Results

No differences could be detected between the two feed-groups in growth, in postmortal macroscopical appearance or in the stereomicroscopical examination. Thus the two groups were evaluated as one.

Stereomicroscopy (Table 1):

Week 1. The villi in all the three areas of the small intestines were fingershaped and slender. There was a considerable difference in length. The longest villi tended to fall over, resulting in an overall unorderly aspect.

Week 2. In the duodenum of two out of six animals the difference in length of the villi became less prominent. Also the villi had become a little more sturdy and less transparent. All other specimens were the same as in the first week.

Week 3. In the duodenum of four out of six animals the villi had become tongue-shaped. In the jejunums no short villi were seen anymore in three individuals. The ileums still had the same aspects as in the first week.

Week 4. The duodenums of all animals showed the same aspect as those of the second week. Tongueshaped villi were not seen. In the jejunum there were no more short villi to be seen. In the ileum of five animals the villi were not changed so the shape was still the same as in the first week. In one animal some villi were growing broader at the base becoming more tongueshaped.

Week 5. The duodenal villi were definitely growing broader at the base and became more tongueshaped. There was still a considerable difference in length. The jejunum of three out of five animals showed broadening of the villous bases. This tendency was also seen in the ileum of one animal. All the other specimens were the same as in the fourth week.

Week 6. In the duodenum the villi were slender but tongueshaped. The jejunums of all animals had broad tongueshaped villi. In the ileum all animals had predominantly tongueshaped villi. The difference in length had disappeared in all parts.

Week 7. The duodenum showed villi that were varying in shape from tongue- or broad tongue- to leafshaped. One out of the five individuals showed ridges. No changes were seen compared to the former week in the jejunum or the ileum.

Week 8. Now the duodenum showed broad tongueshaped and leaveshaped villi and in two out of five animals ridges. The jejunum had broad tongues in all animals. In the ileum the villi were also broad tongueshaped although somewhat more slender than in the jejunum at this age.

Week 9. In the duodenum of three out of six animals only leafshaped villi and in the other three leafshaped villi as well as ridges were seen. The jejunums of all animals showed broad tongueshaped villi. In three individuals however also tongueshaped villi were present, while in the other three also leafshaped villi were seen. In the ileum all animals except one, showed tongue and broad tongueshaped villi; the one animal having broad tongue and leaveshaped forms.

Week 10. The villi in the duodenum of all six animals had become more uniform and had the same aspect as in the ninth week. The villi of the jejunum of all animals showed broad tongueshaped villi. In the ileums tongue and broad tongueshaped villi were still present.

Discussion

The feeding of soy products can at times, impair the growth in rabbits (Sanchez, 1985). The feeding of soy products to calves and piglets can result in morphological changes of the villi in the ileum (Barratt, 1978). The reason for these changes can, in some

instances be due to the presence of lectins (Lorenzsonn,1982). However no influence was noted of the soy roughage (soy-lectins) on the morphogenesis of the villi in rabbits up to ten weeks of age, in comparisson with a diet containing (lectinfree) animal proteins.

Until the fifth week of life the villi in all three parts of the small intestines were fingershaped. There was however much variation in the length of the villi in each sample. As time went by this difference in length deminished. The very short villi disappeared in the duodenum after one week, in the jejunum after three weeks and in the ileum after five weeks of age. These short villi were probably buds of newly formed villi. Their disappearance ment that the final number of villi pro area had been reached. This finding is in contrast with the situation in rats, as was described by Kapadia and Baker (1976) where the number of villi increased up to the third month of age.

In the following three weeks the villi became tongueshaped and then grew out to broad tongues. This tendency was also first seen in the duodenum and last in the ileum. Thus it seems that in the maturation of the intestinal mucosa the duodenum comes first, followed by the jejunum while the ileum comes last. This is also the case in the mouse (O'Connor,1966) and the rat (Toofanian and Targowski,1982). In the human, the calf and the lamb the the intestinal mucosa is fully matured at birth (Toofanian and Targowski,1982).

In the last weeks of this experiment the villi in the duodenum changed into leafshapes and ridges. The jejunum however, showed many leaveshaped villi, but never ridges. The ileum kept its tongueshaped and broad tongueshaped villi, with seldom a leafshaped one. As the enteropathycomplex is mainly a problem in the postweaning period the investigation was not continued after ten weeks of age.

It must be kept in mind that the changes described above are gradual and different shapes are seen next to one another in one specimen as long as the maturation is not completed. As the rabbits were conventially bred and kept, they were of course prone to many (unknown) influences from the environment Under different circumstances the maturation of the intestinal mucosa might be different also. These results will be the base for

investigation of the influences of other diets and of induced changes in the gutflora on the structure of the villi.

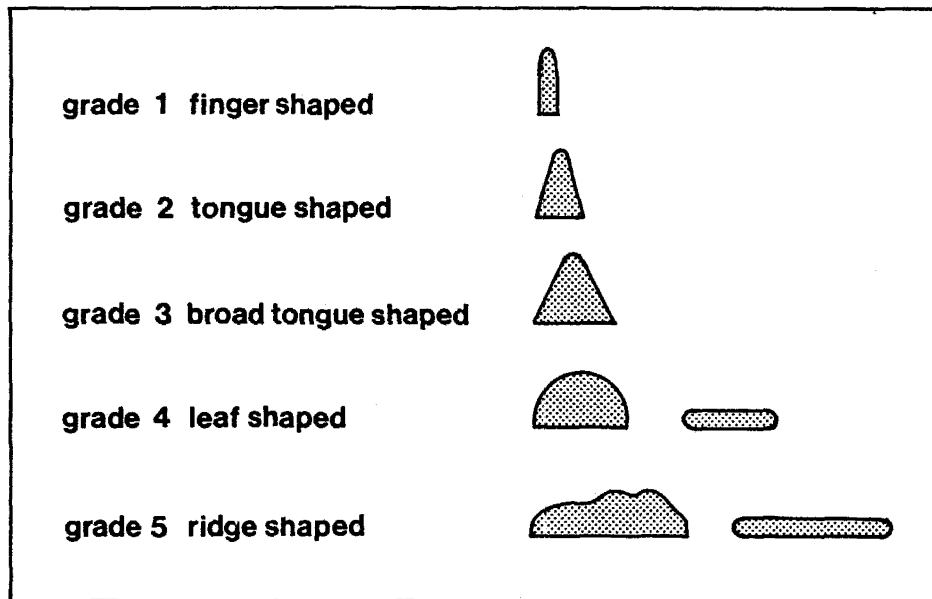


Fig.1. Schematic diagrams of different villous forms in the small intestine of rabbits.

Table 1

Morphogenesis of the villi of the small intestinal mucosa in rabbits, 0-10 weeks of age.

week	duodenum	jejunum	ileum
1	fingershaped(a)	fingershaped(a)	fingershaped(a)
2	fingershaped(b)	fingershaped(a)	fingershaped(a)
3	fingershaped(b) tongueshaped	fingershaped(a,b)	fingershaped(a)
4	fingershaped(b)	fingershaped(b)	fingershaped(a) tongueshaped
5	tongueshaped(b)	fingershaped(b) tongueshaped(b)	fingershaped(a) tongueshaped(b)
6	tongueshaped	broad tongueshaped	tongueshaped
7	tongueshaped broad tongueshaped leafshaped ridges	broad tongueshaped	tongueshaped
8	broad tongueshaped leafshaped ridges	broad tongueshaped	broad tongueshaped
9	leafshaped ridges	tongueshaped broad tongueshaped leafshaped	tongueshaped broad tongueshaped leafshaped
10	leafshaped ridges	broad tongueshaped	tongueshaped broad tongueshaped

a: short and median and long villi b: median and long villi

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Summary

In order to obtain an impression of the morphogenesis of the small intestinal mucosa in rabbits, a stereomicroscopical study was done. Once a week six rabbits were screened, from the age of two days week to the age of ten weeks. A description was made of the villous forms of the duodenum, the jejunum and the ileum. It appeared that the maturation of the duodenum came first, followed by the jejunum while the ileum came last. A difference in villous forms was still apparent in the different small intestinal sections at the end of the experiment. The animals were taken out of two groups that were fed diets with soy-protein or with animal-protein. No difference was noted between the two groups.

Zusammenfassung

Um einen Eindruck zu bekommen von der Entwicklung der Mucosa des Dunndarms bei Kaninchen wurde eine stereomikroskopische Untersuchung durchgeführt. Einmal pro Woche wurden sechs Kaninchen untersucht im Alter von zwei Tage bis zu zehn Wochen. Eine Beschreibung der Darmflocken wurde gegeben von Duodenum, Jejunum und Ileum. Hierbei wurde festgestellt, dass die Reifung zuerst im Duodenum, danach im Jejunum und schliesslich im Ileum stattfand. Ein Unterschied in Flockenformen wurde in den verschiedenen Darmabschnitten noch am ende des Versuches gefunden. Die Tiere stammten aus zwei Gruppen, die mit einem Futter von Soya-Eiweiss oder tierlichem Eiweiss gefutert waren. Es wurde kein Unterschied zwischen beiden Gruppen gefunden.



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