A histological investigation on the stomach and duodenum of the dog after gastroenterostomy

By

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Introduction

It has been recognized by many scientists for long time that the measurement of the acidity in the gastric juice has diagnostically a significant meaning on the infirmity of the stomach and intestines. Indeed, on this matter many reports have been published. Nowadays, too, the distribution of the parietal cells which are said to secrete an oxymuriatic acid which composes the majority of the acidity in the gastric juice, has been investigated by various students from a surgical standpoint of stomach diseases. But these reports fail in histological findings based on more through observation and investigation at various periods after the treatment.

Tsukamoto & Tokii (1953) previously reported the result which was observed during a whole year and more on the varieties in the distribution of the parietal cells of the dogs' stomachs on which were operated the pyloric exclusion.

The author moreover, reports here the result of the observation on the histological finding about dogs' stomachs and intestines after the operation.

Material and Method

In this investigation twelve healthy adult mongrel dogs were used. Three of them were used as control cases. The remaining nine were cut at the line on the two-third way from the distal end of the each dog's stomach. After these nine dog's stomachs were ope-
rated on the pyloric exclusion, they were put to death at the time as will be shown later.

Four stomachs excised from the dogs before they were put to death on the 35th, 100th and 380th day after the treatment, had no diseases macroscopically at the postmortem examination. (Table 1)

Tissue sections M1 and M2 were selected from the intermediate part between the lesser and the greater curvature of the anterior wall of the gastric body on both the amputated and anastomotic sides of the stomach.

In the intestinum duodenum, section D1 was selected from the pylorus, D2 from the gastro-duodenal anastomotic area and D3 from the part under the area D2. They were fixed in 10% formalin and Bouin’s solution as soon as possible, imbedded in paraffin and serial gastric wall sections of 7 μ thickness were cut longitudinally. Sections which were used for observation of the parietal cells and the mucous epithelial cells of the stomach and intestinum duodenum were stained with Haematoxylin-eosin. In order to observe tissue fibers, other sections were stained with Azan, Weigert-elastin and Van-gieson.
A histological investigation on the stomach and duodenum

Findings

A. Parietal cells
Case No. 1
Forms of the parietal cells on the amputated and anastomotic sides of the stomach are round or elliptic and sizes are almost the same as those of the control case. The marginal region of the cytoplasm stains deeply. Nucleus is almost round and it can be noticed in the center of the cytoplasm. The stainabilities of the cytoplasm and nucleus are low as compared with those of the control case. No other differences with the control cases are noticed.

Case No. 2
On the amputated side of the stomach, shapes of the parietal cells are generally round, but sizes are greater than those of the control case. The stainabilities of the cytoplasm and nucleus are low, besides, they depend on the quality of each cell. Most nuclei are round in shape, but there are two groups i.e. one consists of the nucleus

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Table 2. microscopic findings in fibres
with its positions in the center of the cytoplasm and another has the
nucleus with its positions in the peripheral region. (Photo. No. 2)

On the anastomotic side of the stomach, the forms of all parietal
cells are round and the sizes are almost the same as those of the
control case. Both the cytoplasm and nucleus do not stain at all and
they are seen to be pellucid. (Phot. No. 3)

Case No. 3
Forms and sizes of the parietal cells on the amputated and ana-
stomotic sides of the stomach are indeterminate and the cytoplasm
and nucleus stain deeply. The nucleus is round in shape and it is
noticed in the central part of the cytoplasm.

Case No. 4
In comparison with the control case, though forms and sizes of
the parietal cells on the amputated and anastomotic sides of the
stomach are almost the same, the stainability of the cytoplasm and
nucleus is lower. The nucleus is round in shape and it is recognized
in the central area of the cytoplasm.

B. Epithelial cells of gastric mucous membrane

Case No. 1
The height and width of the epithelial cell on both amputated
and anastomotic sides of the stomach are smaller than those in the
control case. Especially the height of the epithelial cell on the anas-
tomotic side of the stomach is half of that in the control case.
The stainability of the cytoplasm and nucleus is weaker than that of
the control case, and the nucleus which flattens out transversally is
noticed in the center of the cytoplasm. (Photo. No. 6)

Case No. 2
The epithelial cells on the amputated side of the stomach are
smaller than those of the control case, and the height of the cells is
one-third of the control case. The cytoplasm and nucleus have a
faint stainability. The former stains only at the margin of it and the
latter which is round in shape is noticed on the base of the cell.
(Photo. No. 7)

The height, width and stainability of the epithelial cells on the
anastomotic side of the stomach are smaller than those of the control
case. But these reduction are not so intensive as those on the am-
putated side of the stomach.

Case No. 3
The epithelial cells on the amputated and anastomotic sides of the
A histological investigation on the stomach and duodenum

Stomach are smaller than those of the control case, but not so remarkable as those of the case No. 1 and No. 2.

The nucleus which is almost round in shape is recognized on the base of the cell.

Case No. 4

In comparison with the control case, the epithelial cells on the amputated and anastomotic sides of the stomach are smaller in the height and width, but the stainability of the cytoplasm and nucleus is the same. The nucleus is oval in form as that of the control case and it is noticed on the base of the cell.

C. Mucous epithelial cells on the intestinum duodenum

Case No. 1

The epithelial cells of each area D₁, D₂ and D₃ are smaller in the height and width than those of the control case and the stainability of the cytoplasm and nucleus is more faint. Area D₁, above all, has the lowest height which is half of the control case.

The nucleus of the epithelial cells is elliptic in shape and it is noticed on the base of the cell.

A or two nucleoli are noticed in the nucleus.

Case No. 2

The epithelial cells of each area D₁, D₂ and D₃ are smaller in the height and width than those of the control case but not so small as those in case No. 1.

In this case, area D₁ is, also, most remarkable in the reduction of the cells. The stainability of the epithelial cells, in general, is faint. The shape of the nucleus is elliptic and in the nucleus one or two nucleoli are found.

Case No. 3

The epithelial cells of each area D₁, D₂ and D₃ show a remarkable reduction in size, especially the height of the cells of area D₂ is half of that of the control case.

The colour of the cytoplasm and nucleus of the epithelial cells is dark orange violet. The stainability of the cytoplasm and nucleus of the epithelial cells of area D₁ and D₃ is weak but their stained color are of dark orange-violet coloration.

The nucleus of the epithelial cell of each area D₁, D₂ and D₃ is smaller than that of the control case, and it is noticed on the base of the cell.

Case No. 4
The size of the epithelial cells of each area D1, D2, and D3 is small and it is the same or somewhat smaller than that of the control case. The stainability of the cytoplasm and nucleus is the same as that of the control case. The nucleus which is noticed on the base of the cell is round in shape.

D. Connective tissue fibers on the lamina propria mucosae, especially on the lamina muscularis mucosae of the intestinum duodenum and the anastomotic and amputated sides of the stomach.

Case No. 1

The collagenous, elastic and reticular fibers on the lamina propria mucosae of both amputated and anastomotic sides of the stomach are more dense in their structures than those in the control case, and the layer is, too, thicker. Moreover, the thickness of the layer on the amputated side of the stomach is greater than that on the anastomotic side. (Photo. No. 10, 11.)

On the lamina propria mucosae of the intestinum duodenum, the structure (Photo. No. 12) of the elastic and reticular fibers in area D3 is more dense than that in the control case. But in area D1 and D2, the structure of these fibers is almost the same, except the thickness of the layer, as that in the control case (Photo No. 13, 14.).

Three kinds of fibers on the lamina propria mucosae of the amputated and anastomotic side of the stomach follow towards a gradual reduction with the periods as will be shown in case No. 2 and No. 3.

But their structure is more dense and the thickness of the layer is greater than those of the control case. Moreover, these varieties are more intensive in the amputated side than in the anastomotic side of the stomach.

Case No. 2

On the lamina propria mucosae of the intestinum duodenum, only the reticular and elastic fibers in area D3 show the same appearance as those in the control case.

Three kinds of fibers in area D1 and D2, and the collagenous fibers in area D3 show a reduction in their quantity, as compared with the control case.

Case No. 3

The quantity of the collagenous fibers on the lamina propria mucosae in each area D1, D2 and D3 shows a remarkable reduction as invisible (Photo No. 15). In area D2, the elastic and reticular fibers are not recognizable. Only the reticular fibers in area D3 are almost
the same in quantity as the control case.

Case No. 4

The structure of three kinds of fibers on the lamina propria mucosae of the amputated and anastomotic sides of the stomach is about the same as that in the control case, but that of the amputated side seems to be more dense in its quantity than that of the anastomotic.

On the lamina propria mucosae of the intestinum duodenum, the reticular, elastic and collagenous fibers are the same in their structure as in the control case (Photo. No. 16) but the quantity of these fibers in all areas show a certain reduction.

4. Consideration

In case No. 1
1) Parietal cells.

The parietal cells of both amputated and anastomotic sides of the stomach are round or elliptic in shape and one does not find any differences with those of the control case except for having a weaker stainability. About this fact, Abe (1951) has reported that the stainability and form of the parietal cells of the excised human stomach in three weeks after the vagotomy in man's, showed no difference with those of the control case. Masaki (1934) has published that the total acidity of the dog's gastric juice which went by about one month after V. Eiselsbery's pyloric exclusion, was the same as the condition before the treatment.

These two reports seem to have a relationship with the result of my study.

2) Mucous epithelial cells of the stomach and intestinum duodenum.

As compared with the control case, the epithelial cells of the amputated and anastomotic sides of the stomach are smaller in the thickness and width, besides, weaker in stainability of the nucleus and cytoplasm. Especially the height of the epithelial cells of the anastomotic side is half of that of the control case and the nucleus which is noticed on the base of the cell is elliptic transversally as if it was pressed.

This fact is due to the weak stimulation on the amputated side of the stomach which is a result of the pyloric exclusion, on the contrary, the anastomotic side receives a considerable stimulation owing to taking food.

On the anastomotic and amputated sides, a remarkable variety in
the epithelial cells is found in the period where no variety in the parietal cells is found.

Considering Abe's report in which he says that the parietal cells appear behind the destruction of the chief, accessory and epithelial cells, my findings are interesting.

As the varieties in the mucous epithelial cells of the intestinum duodenum, all the epithelial cells on each area D1, D2 and D3 are small in their height and width as compared with those of the control case, and the stainability of the cell is weaker, too.

The fact that the extent of the reduction on area D1 is of the most remarkable, is seem to be due to a stimulation by the accumulated juice of the intestinum duodenum and pancreas on the amputated side of the stomach.

3) Connective tissue fibers on the lamina propria mucosae of the amputated and anastomotic sides of the stomach and the intestinum duodenum.

Changes in tissue fibers on the lamina propria of the amputated and anastomotic sides of the stomach are great as compared with those in the control case, namely, the fiber structure becomes more dense and its layers also become thicker. But the change in the anastomotic side of the stomach is not so great as that in the amputated side. This fact is considered to demonstrate the reducing in quantity of the amputated side of the stomach.

Changes in tissue fibers on the lamina propria mucosae in each area of the intestinum duodenum are different with those in the amputated and anastomotic sides of the stomach.

The collagenous fibers in area D3 and the reticular, elastic and collagenous fibers in area D1 and D2 show a reduction in quantity as compared with the control case, but only reticular and elastic fibers in area D3 show somewhat an increase in quantity as compared with the control case.

These facts are seem to be interesting thing when changes in tissue fibers on the amputated and anastomotic sides of the stomach are considered.

In case No. 2

1) Parietal cells on both amputated and anastomotic sides of the stomach and mucous epithelium on both sides of the stomach and the intestinum duodenum.

The shape of the parietal cells on the amputated side of the stomach is round and the size is greater than that of the control
A histological investigation on the stomach and duodenum

The stainability of the cytoplasm and nucleus is weaker, besides, conditions of the stainability depend on the character of each cell.

Considering the reduction of the epithelial cells which is one-third of the height of the control case and the reduction of the stainability, these facts seem to be an intensive atrophy resulting from a chemical stimulus by various juices which accumulate on the amputated side of the stomach.

The parietal cells on the anastomotic side of the stomach are round in shape and are the same in size as that of the control case. But the cytoplasm and nucleus have no stainability and they seem to be transparent. On the epithelial cells, the stainability is weaker and the size is smaller than that of the control case.

It is considered to be in relationship with Shigaura's study (1952) that the parietal cells in the stomach which suffer from chronic atrophy fade out.

The mucous epithelium of the intestinum duodenum shows a reduction in its quantity on every area and in its stainability too. Especially the intent of reduction in quantity is greatest in area D1.

2) Connective tissue fibers on the lamina propria mucosae of the intestinum duodenum and the amputated and anastomotic sides of the stomach.

The collagenous, reticular and elastic fibers on the lamina propria mucosae on the amputated and anastomotic sides of the stomach present about the same reduction in quantity as in case No. 1.

But the fibers on the amputated side are more numerous than on the anastomotic.

On the lamina propria mucosae, changes in the reticular fibers are so great that they are not recognizable in area D1. The reticular and elastic fibers in area D1 and D2 except D3 are remarkable in their quantitative reduction.

Case No. 3.

1) Mucous epithelial cells of the intestinum duodenum and on the amputated and anastomotic sides of the stomach, and the parietal cells on both sides of the stomach.

Size and shape of the parietal cells on the amputated and anastomotic sides are various and the cytoplasm and nucleus stained deeply. The nucleus which is round in shape is noticed on the center of the cytoplasm.

Judging from Masaki's opinion that the total acidity of the gastric juice in the 90th day after the operation is higher than that
before the operation, the parietal cells in this case appear to recover their function. The mucous epithelial cells on both sides of the stomach are low in height and width as compared with the control case. Though the stainability of the cells is weak, too, the reduction is faint as compared with case No. 1 and 2. This fact may be a figure of functional recovery. It suggests that notwithstanding the regressive change of the parietal cells is later than in the mucous epithelium, the recovery of the parietal cells takes the same time as the mucous epithelium.

The reduction of the epithelial cells on the lamina propria mucosae of the intestine duodenum is remarkable in every area, especially in area D2, it is half in height of the control case. The reduction in area D1 and D3 is greater than that in case No. 1 and 2. The stainability of the cells is also weak. It suggested that the various juices which accumulated in the amputated side, and the pathological change in the anastomotic side of the stomach were factors of these changes.

2) Connective tissue fibers on the lamina propria mucosae of the amputated and anastomotic sides of the stomach and the intestine duodenum.

Various fibers existing on the lamina propria mucosae on both sides of the stomach are less in their quantity as compared with case No. 1 and 2, but are more numerous than that of the control case. The fibers on the amputated side show more increase than that on the anastomotic.

On the lamina propria mucosae of the intestine duodenum, the collagenous fibers are not found in every area and besides, in area D2 the reticular and elastic fibers are not noticable.

These remarkable changes are relate to the marked atrophy of the mucous epithelial cells of the intestine duodenum. Moreover, these changes are contrary to those in tissue fibers on the lamina propria mucosae on both sides of the stomach and to those in the mucous epithelial cells on both sides of the stomach.

Case No. 4

1) Parietal cells on the amputated and anastomotic sides of the stomach and the mucous epithelial cells of the intestine duodenum. The shape, size and stainability of the parietal cells on both sides of the stomach return to normal. Moreover, the shape, size, stainability of the mucous epithelial cells of both sides of the stomach, and the condition of the nucleus are noticed as well as those of the control case. On the contrary, the epithelial cells in every area of the intestine duodenum...
duodenum show a reduction in the height and width as compared with the control case but not so intensive as in case No. 3.

2) Connective tissue fibers on the lamina propria mucosae of both amputated and anastomotic sides of the stomach and the intestinum duodenum.

Though the tissue fibers on the lamina propria mucosae on both sides of the stomach are of the same picture as the control case, the various fibers on the amputated side of the stomach show more increase in their quantity than those on the anastomotic side.

On the lamina propria mucosae, the collagenous, reticular and elastic fibers except D₃ show more reduction in their quantity than those of the control case.

On the finding which is noticed in the 380th day after the operation, the tissue fibers existing on the lamina propria mucosae on the anastomotic and amputated sides of the stomach show their return to normal as in the control case, but those on the lamina propria mucosae of the intestinum duodenum are not always in the same condition as in the control case.

5. Conclusion

1) Parietal cells.

At the 35th day after the operation, no remarkable changes in the parietal cells on the amputated and anastomotic sides of the stomach were found.

At the 50th day after the operation, the shape of the parietal cells on the amputated side of the stomach was round or elliptic, but their sizes were bigger than those of the control case. Moreover the stainability of the cytoplasm and nucleus was weaker than that of the control case.

On the anastomotic side of the stomach, the shape of the parietal cells was round but the cytoplasm and nucleus did not stain at all.

At the 100th day after the operation, the shape and size of the parietal cells on both sides of the stomach were various and the stainability of the cytoplasm and nucleus became better.

At the 380th day after the operation, the shape, size and stainability of the parietal cells on both sides of the stomach were almost the same in their extent as those of the control case.

2) Mucous epithelial cells of the stomach.

At the 35th day after the operation, the epithelial cells on the amputated and anastomotic sides of the stomach showed the reduction
in their height and width as compared with those of the control case. Especially the height of the cells on the anastomotic side of the stomach was half of that of the control case, and the nucleus became an elliptic shape transversally.

At the 50th day after the operation, the epithelial cells on both sides of the stomach showed a reduction, especially on the amputated side of the stomach the extent of the reduction of the parietal cells was remarkable, namely, the height of them were one-third of the control case. The stainability of the cytoplasm and nucleus was faint.

At the 100th day after the operation the epithelial cells of both sides of the stomach showed some reductions, while the reduction was weaker in its extent than that in the cases at the 35th day and 50th day after the operation.

At the 380th day after the operation, the epithelial cells on the both sides of the stomach showed almost the same condition as those of the control case.

3) Mucous epithelial cells of the intestinum duodenum.

At the 35th and 50th day after the operation the epithelial cells in each area showed a reduction as compared with those of the control case and stainability was weak. Especially the reduction in area D_1 was most intensive in its extent.

At the 100th day after the operation, the extent of the reduction was the greatest out of all the cases after the operation, particularly in area D_2 the height of the epithelial cells was half of that of the control case.

At the 380th day after the operation, the extent of the reduction in the epithelial cells in every area became weaker but it was strong as compared with the cells of the control case.

4) Connective tissue fibers on the lamina propria mucosae on the lamina muscularis mucosae on the amputated and anastomotic sides of the stomach at all the periods after the operation, the collagenous, reticular and elastic fibers on the lamina propria mucosae on both sides of the stomach showed the same changes as those of the control case.

Three kinds of fibers on the amputated side of the stomach appeared to show some increase in their quantity.

5) Connective tissue fibers on the lamina propria mucosae above the lamina muscularis mucosae of the intestinum duodenum.

Out of all periods after the operation, only elastic and reticular fibers in area D_3 at the 35th day after the operation showed more
A histological investigation on the stomach and duodenum

Increase in quantity than those of the control case. At the 100th day after the operation, the collagenous fibers in each area D₁, D₂ and D₃ were scarcely noticeable.

At the 380th day after the operation various kinds of fibers in area D₃ were noticeable as well as those in the control case, but the fibers in area D₁ and D₂ showed a reduction in their quantity as compared with those of the control case.

The author wishes to extend his grateful thanks to Prof. Dr. T. Taniguchi and Assist. Prof. Dr. Shimai who gave advice and criticism.

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Plate I

No. 1. Parietal cells of the control dog's stomach.

No. 2. Parietal cells of the amputated side of the stomach at 50 days after operation

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Plate II

No. 3. Parietal cells on the anastomotic side of the stomach at 50 days after operation.

No. 4. Parietal cells on the amputated side of the stomach at 380 days after operation.

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No. 5. Mucous epithelial cells of the control dog's stomach.

No. 6. Mucous epithelial cells on the anastomotic side of the stomach at 35 days after operation.

S. Tokii
No. 7. Mucous epithelial cells on the amputated side of the stomach at 50 days after operation.

No. 8. Mucous epithelial cells on the amputated side of the stomach at 380 days after operation.

S. Tokii
No. 9. Fibres on the lamina propria mucosae of the control dog's stomach (Van Gieson).

No. 10. Fibres on the lamina propria mucosae on the amputated side of the stomach (Van Gieson) at 35 days after operation.

S. Tokii
No. 11. Fibres on the lamina propria mucosae on the anastomotic side of the stomach at 35 days after operation (Van Gieson).

No. 12. Fibres on the lamina propria mucosae of the control dog's intestinum duodenum. (Van Gieson)

S. Tokii
No. 13. Fibres on the lamina propria mucosae of the intestinum duodenum on the amputated side at 36 days after operation. (Van Gieson)

No. 14. Fibres on the lamina propria mucosae of the inferior part of the intestinum duodenum at 35 days after operation. (Van Gieson)

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Plate VIII

No. 15. Fibres on the lamina propria mucosae of the intestinum duodenum on the anastomotic side at 100 days after operation.

No. 16. Fibres on the lamina propria mucosae of the inferior part of the intestinum at 380 days after operation.

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