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Comparison of the Pathological Changes between Blocking the Stomach Meridian and the Kidney Meridian in Mini-pigs*

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Abstract In previous studies, it was found that blocking the low hydraulic resistance channel (LHRC) along meridian in mini-pigs could lead to the hyperalgesia, a series of abnormal behavioral changes, traditional Chinese medicine (TCM) syndromes and abnormal autopsy in internal organs. The objective of this paper is to investigate the pathology of these changes. Mini-pigs were randomly divided into a stomach meridian blocking group (SBG, n=8), a kidney meridian blocking group (KBG, n=8) and a control group (CG, n=6). The hydraulic gel was injected separately into LHRCs along the stomach meridian and the kidney meridian. The pigs were then fed 7 to 9 weeks, and several indexes were observed. The results showed that the blood serum creatinine increased extremely in all 3 groups and the level in the KBG was lower than that in the SBG by 13.76% ($P<0.05$) and in the CG by 14.51% ($P<0.01$). HE staining results showed that more than half of the pigs had the heart abnormalities in the CG, the liver abnormalities in the SBG and the kidney and testicles abnormalities in the KBG. Intestinal sections in the SBG showed that the intestinal crypt depth of the duodenum and the colon, and the total mucosal thickness of the large intestine were significantly higher than those of the CG. The jejunal V/C and the ileal crypt depth were significantly lower than those of the KBG, and the ileal V/C was significantly higher than that of the KBG. Compared with the CG, intestinal sections of the KBG showed that the duodenal crypt depth and the thickness of the colon was significantly higher than that of the CG. The GAS in the KBG was significantly higher than those of the CG and the SBG. The results verify that the blockage of LHRC along the stomach meridian and the kidney meridian can lead to different pathological phenomena, which provided a scientific basis for the syndromes induced by meridian stasis.

Key words meridian stasis, model, pathological change, stomach meridian, kidney meridian, mini-pig
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1 Introduction

Meridians are indispensable part in the theory of traditional Chinese medicine (TCM). As channels connecting the body surface and viscera, they can transport qi and blood and reflect viscera diseases on the body surface. When meridians are blocked, they can lead to abnormal flowing of qi and blood, which may affect the function of visceral organs and eventually lead to disease. The stimulation of acupuncture and massage on the meridians can treat visceral diseases. Although meridians are vital for human health, we could not explain the real modern structure in the language of modern medicine.

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Researchers have proposed different hypotheses about the essence of meridians. As the commander of the human body, scientists study the nervous system not only in herbal medicine but also in meridians[1]. Some researchers consider that meridians are a system based on the function of nervous. For example, Zhu Bing and his team[2] found that intestinal diseases induce referred pain on the body surface that is the same as or adjacent to the location of the spinal segment corresponding to the affected intestinal sections. However, most of the studies are focusing on a point of the meridian, which is known as an acupoint. Some other researchers consider that meridians are associated with the fascia system. For example, Yang *et al*.[3] thought that fascia could provide a structure that assists fluid flowing, holds memory and is highly innervated, and its mechanotransduction and regeneration of physiological effects by needling on basic cellular mechanisms could explain the essence of acupuncture. In addition, some researchers consider that meridians may function *via* collagenous bands. Ahn *et al*.[4] found that needling could lower electrical impedance and researched the reason for an increasing ultrasound echogenicity on the collagenous bands, a finding that could provide important insights to the essence of meridians.

There are many other perspectives about the structure of meridians. Among them, Zhang *et al*.[5] considers that meridians are low hydraulic resistance channels (LHRC) in the human body, which can be measured using continuous flow resistance measurement and tissue hydraulic wave propagation measurement methods. Based on the hypothesis, Zhang and his team[6-7] measured the hyperalgesia, observed the function of primary substance in LHRC and the mechanism of regulating LHRC. Then a pathological model of blocking meridians in mini-pigs was built which featured bloated stomach or/and intestine[8] and abnormal behavioral changes in fence climbing frequency and nighttime activity frequency[9]. A macroscopic and quantitative observation method was established to systematically research the model that was based on the clinical syndromes in TCM[10]. It was found that blocking the LHRC along the stomach meridian could induce pathological changes that were related to the stomach meridian and the gastrointestinal system, and blocking the LHRC along the kidney meridian could induce pathological changes related to the kidney meridian and the urogenital system[11].

However, the pathological mechanism of these changes has not been clearly researched. On the foundation of the macroscopic and quantitative observation results, this article focuses on the pathological and morphological changes in the model.

2 Material and method

2.1 Animal conditions and groups

The investigation adhered to the principles of care and use of laboratory animals has been approved by the Institutional Animal Care and Use Committee (license number: 120101) of Institute of Chinese Materia Medica, China Academy of Chinese Medical Sciences.

A total of 22 Chinese experimental black mini-pigs were provided by the Beijing Kexing Experimental Animal Breeding Center [weight: (9± 2) kg, male, 1 ~ 2 months of age] [The production license is SCXF-(Beijing)-2017-0003]. The pigs were housed separately in cages for large animals, 1.1 m × 0.7 m × 0.8 m in size. The pigs were temporarily housed in the animal laboratory at (20 ± 2)℃ with a relative humidity of 50% ± 10% (license number: SYXK Beijing 2011-0014) in the Institute of Acupuncture & Moxibustion, China Academy of Chinese Medical Science, for 7 days of detailed observation. After the blockage, the pigs were sent to the Kexing Experimental Animal Breeding Center for 7 to 9 weeks breeding. The pigs were fed twice a day with 150 g of pig feed in the morning and 100 g in the evening and had unlimited drinking water. The light was simulated day and night by turning on the light at 8: 00 a. m. and turning off the light at 8: 00 p. m. automatically.

All the animals were randomly divided into 3 groups: 8 pigs in the stomach blocking group (SBG), 8 pigs in the kidney blocking group (KBG) and 6 pigs in the control group (CG).

2.2 Gel injection

The method described in the previous paper was used to locate the low hydraulic resistance points (LHRP)[1]. The hair was removed from the LHRC area. A low impedance meridian locator (type: WQ6F30, made by Donghua Company in China) was used to locate low impedance points, and the distance between two points was approximately (1.5 ± 0.5) cm. The SBG was tested to determine the region of the stomach meridian and the KBG was tested to determine the region of the kidney meridian. The CG was anesthetized without any other operation. Then, the LHRP values were measured by a pressure differential continuous HR detector[5, 12]. After the measurement of the LHRP, the gel (Macrolane, Uppsala company in Sweden) with Alcian Blue (8 GX, Sigma Co., USA) (10 ml gel mix 0.3 ml 1% Alcian Blue) was injected into the LHRP, which was described in detail in a previous paper[10]. The amount of gel for each point ranged from 0.5~1.0 ml (Figure 1). After finishing all the operations, the pigs were sent back to the animal house.

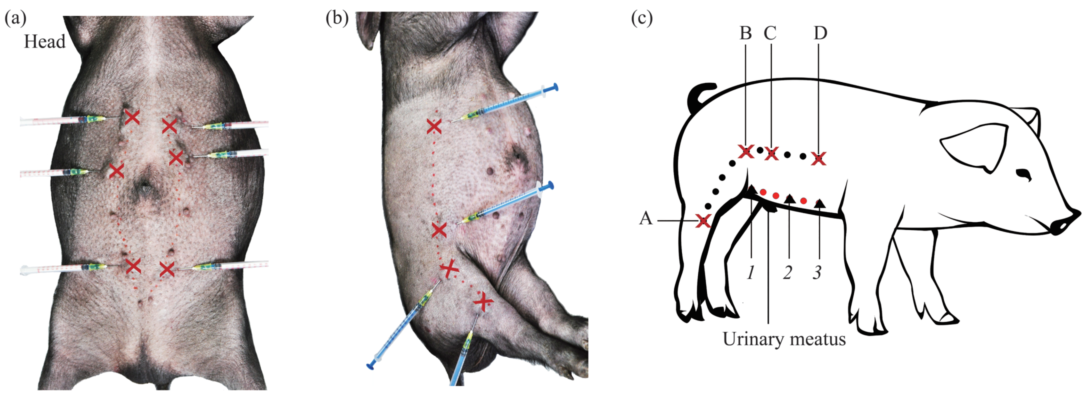

Fig. 1　The area of the LHRC along the meridian shown on the skin of pigs

The point of the needle of the injector (X or ▲) indicates the LHRP and the red point on the skin is the low resistance point along the stomach meridian (a) and the kidney meridian (b). The line of A-D is the stomach meridian, and the amounts of gel used were 0.5 ml (A), 0.5 ml (B), 0.7 ml (C) and 1.0 ml (D). The line of *1−3* is the kidney meridian, and the amounts of gel used were 0.8 ml (*1*), 1.0 ml (*2*) and 0.9 ml (*3*)[10] (c).

2.3　Experimental procedure

After 7 to 9 weeks, the pigs were anesthetized and the blood was collected from the ear vein for 2 ml. Then the bilateral carotid arteries were isolated to bleed for sacrifice. An injector was used for collecting urine by puncturing the bladder wall. Samples were collected randomly from the following organs: heart, liver, spleen, stomach, lung, kidney, bladder, pancreas, cecum, colon, rectum, duodenum, jejunum, ileum, testis and prostate. The samples were placed in a 2.5% poly-formaldehyde-glutaraldehyde mixture for preservations and were later made into paraffin sections. Meanwhile, the stomach sample was made into sections using an immunohistochemical staining technique.

An Olympus microscope was used to observe the tissue slices and images were collected and processed using the Motic Image analysis system. For the small intestine sections, the five longest villi and crypts in the field of view were measured by a ruler tool in the analysis system and the average value was calculated. The mucosal layer with the widest 5 segments in the field of view was measured in each large intestine section and the average value was calculated.

2.4　Statistical analysis

The yellow, brown-red granules or clumps of gastrin-positive signals were shown in the immunohistochemical sections of stomach. Sections were observed using a light microscope under 40× magnification and 5 positive fields were selected for counting in each stomach tissue. The immunohistochemical positive surface density (immunohistochemical positive area density = positive signal area / measured area) was determined by the Motic Image analysis system.

The statistical software SPSS18.0 was used for statistical analysis and the measurement data are expressed as the mean value ± standard deviation ($\bar{x}$±s). The data were analyzed by independent sample t-test or nonparametric test.

3 Results

3.1 Biochemical index test results

The blood detection revealed that there was no significant difference between groups or by self-matching test in BUN ($P>0.05$). The increasing rates of CRE were 63.83% (CG), 69.84% (SBG) and 26.54% (KBG) after intervention, and the CRE value of the KBG was lower than those of the CG and the SBG by 15.25% and 14.05%, indicating extremely significant differences ($P<0.01$) (Table 1) .

Table 1　Blood urea nitrogen and serum creatinine values of each group

Parameters	BUN （mmol/L）			CRE （μmol/L）			
	Before	After	*P* value	Before	After	*P* value	*P* values compared with KBG
CG（$n=6$）	3.40±0.68	3.48±0.98	0.91	51.20±1.56	83.88±07.74$^{**\triangle\triangle}$	0.000	0.010
SBG（$n=8$）	2.82±0.42	3.19±0.96	0.48	48.70±2.13	82.71±11.04$^{**\triangle\triangle}$	0.000	0.028
KBG（$n=8$）	2.32±0.49	2.79±0.83	0.33	56.18±7.30	71.09±^{0}6.00$^{\triangle\triangle}$	0.004	—

$^{\triangle\triangle}$ Represents $P<0.01$ *vs*. before blocking; ** Represents $P<0.01$ *vs*. the KBG.

No obvious abnormality was revealed in urine tests of NIT, PH, BIL, URO and WBC. The GLU results revealed that there was one pig in each group showing various degrees of positivity. The SBG of urine in the stomach group and the CG were in the reference range (53.72−112.36) [13], while the SBG was out of the reference range in the KBG, indicating that the KBG was significantly higher than those of the CG (1.47%) and the SBG (1.36%). The BLD of the three groups was positive to varying degrees. One pig each in the CG and the KBG showed positive indicators of PRO. The results of KET revealed that 25% of pigs in the SBG and the KBG had positive indicators (Table 2).

Table 2　Urine detection after blocking LHRC

Parameters	NIT	PH	GLU	SG	BLD	PRO	BIL	URO	KET	WBC
CG（$n=6$）	−	6.80	20%	1.012*（P=0.018）	80%	−	−	−	−	−
SBG（$n=8$）	−	6.42	−	1.014*（P=0.018）	43%	−	−	−	29%	−
KBG（$n=8$）	−	5.43	14%	1.028	43%	−	−	−	29%	−

* Represents $P<0.05$ *vs*. the KBG.

3.2 HE staining and section observation

More than half of the pigs had the heart abnormalities in the CG, the liver abnormalities in the SBG and the kidney and testicles abnormalities in the KBG. Less than half of the pigs had abnormalities occasionally in other organs (Figure 2). Some typical images are shown in Figure 3−12 (H•E, bar=50 μm).

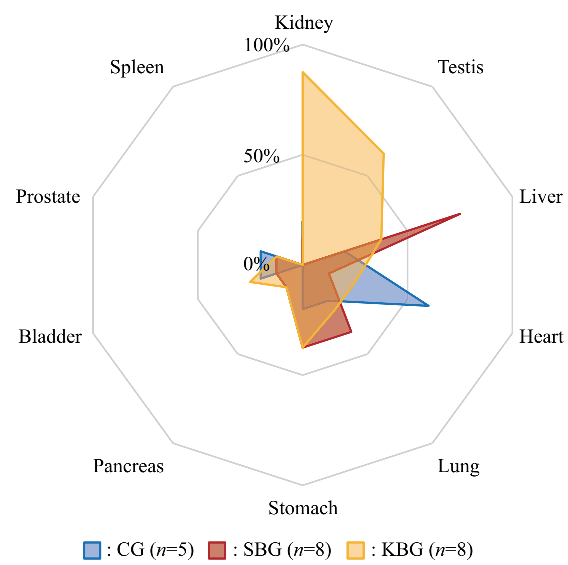

Fig. 2　Statistical graph of HE staining

3.3 Statistical results of intestine

There was no statistically significant difference in the lengths of villi in the duodenum, jejunum and ileum of each group ($P>0.05$) (Figure 13). The duodenal crypt depth in the SBG was significantly greater than that in the CG by 22.45% ($P<0.05$). The duodenal crypt depth in the KBG was significantly greater than that in the CG by 26.33% ($P<0.01$). The ileum crypt depth in the SBG was significantly lower than that in the KBG by 13.59% ($P<0.01$) (Figure 14).

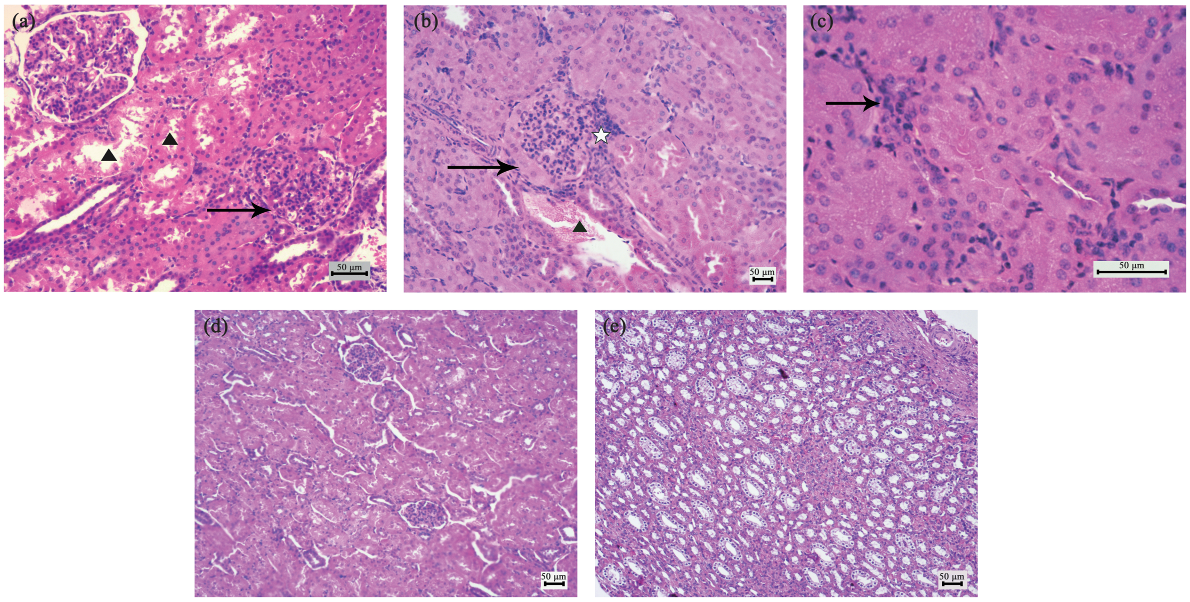

Fig. 3　The kidney tissue in mini-pigs

The glomerular capsule is stenosis (→) and the renal tubular epithelial cell is necrosis and exfoliation (▲) (a, KBG). The glomerular endothelial is hyperplasia (→), and there is inflammatory cell infiltration(☆) and expansion of renal interstitial blood vessels within congestion (▲) (b, KBG). Renal cortex is infiltrated with inflammatory cell (→) (c, KBG). The normal glomerulus and kidney tubules are well organized (d, SBG; e, CG).

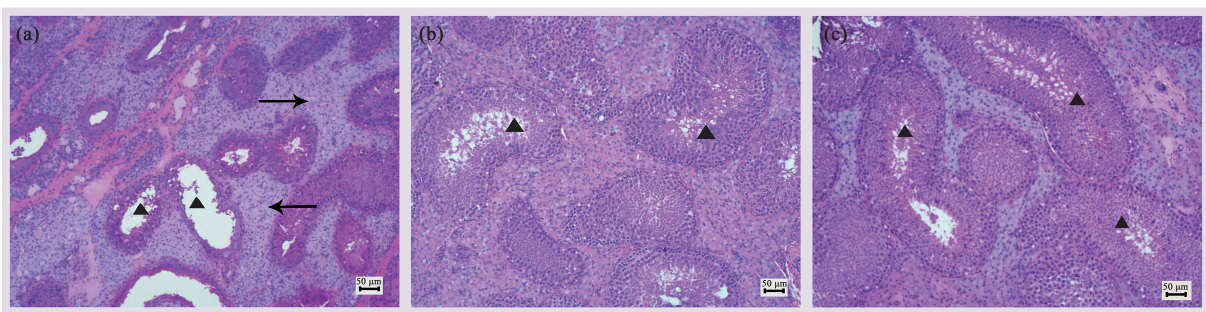

Fig. 4　The testis tissue in mini-pigs

The testicular stroma is widen (→), and the seminiferous tubule are atrophied and different levels of spermatogenic cells are less than the normal state (▲) (a, KBG). Normal levels of spermatogenic cells are observed (▲) and the testicular stroma is normal in the testis (b, SBG; c, CG).

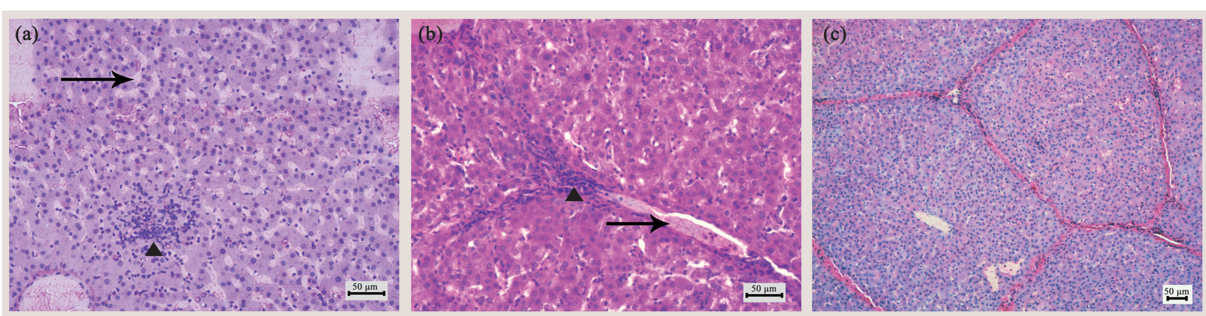

Fig. 5　The liver tissue in mini-pigs

The hepatic lobule shows inflammatory cell infiltration (▲) and broadening hepatic discus (→) (a, SBG). The portal area of liver shows inflammatory cell infiltration (▲) and interlobular vein congestion (→) (b, KBG). The normal structure of the hepatic lobule and hepatic sinus endothelial cells are clear and the central vein is the central cord of hepatocytes arranged radially (c, CG).

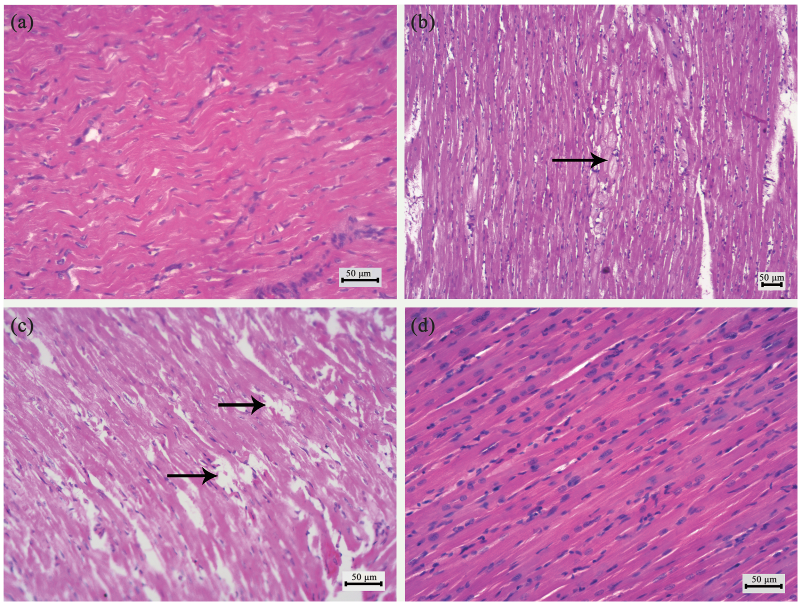

Fig. 6　The heart tissue in mini−pigs

In several pigs, myocardial fiber shows extensive wave necrosis (a, CG), liquefaction necrosis (→) (b, SBG) and slight rupture and necrosis (→) (c, KBG). The normal myocardial fibers is stained uniformly, the cell boundaries is clear and no abnormalities is observed in the interstitium (d, CG)

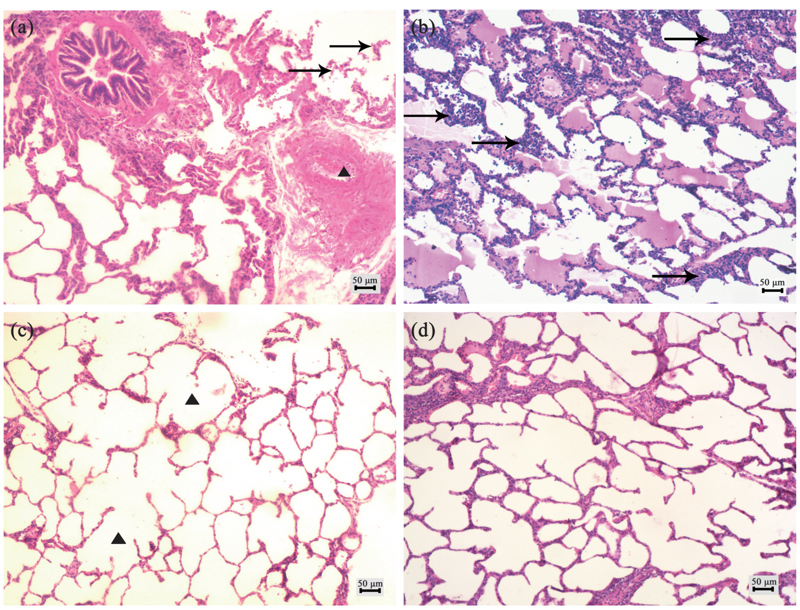

Fig. 7　The lung tissue in mini−pigs

There is a small amount of blood congestion in pulmonary capillaries (▲) and a small amount of bronchial epithelial cell exfoliation (→) (a, CG), and a large amount of exudate with inflammatory cell infiltration (→) (b, SBG) and slightly alveolar expansion (▲) (c, KBG). The structure of normal alveoli is clear and there is no obvious abnormality in the lung tissue (d, CG).

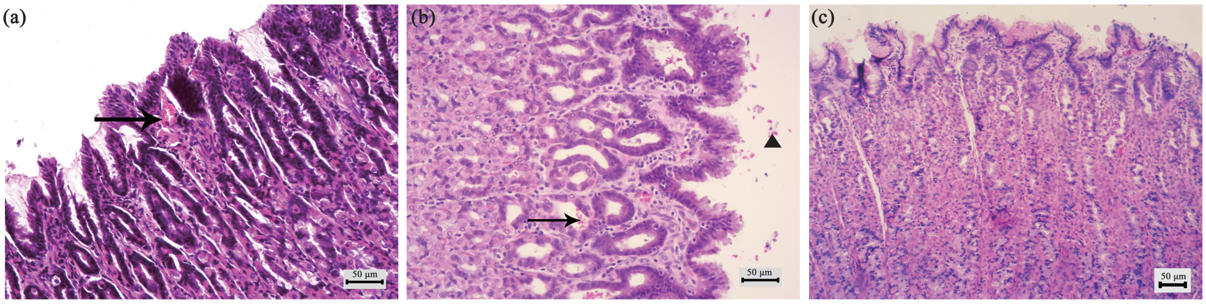

Fig. 8　The stomach tissue in mini-pigs

There is slight congestion of the gastric mucosa (→) and mucosal epithelial detachment (▲) (a, SBG; b, KBG). The normal structure of the gastric mucosal layer, submucosal layer, muscular layer and serosal layer is clear (c, CG).

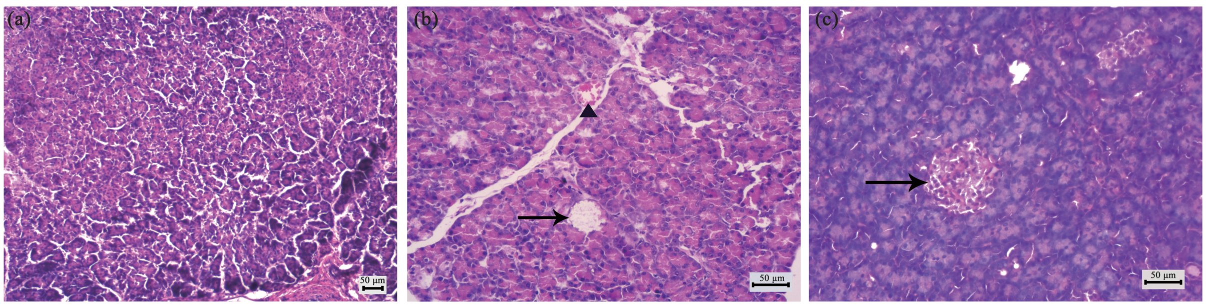

Fig. 9　The pancreas tissue in mini-pigs

The pancreatic structure has slight granular necrosis and the number of islets is decreasing occasionally (a, SBG). There is slight congestion in the veil (▲) and the islet is disappearing occasionally (→) (b, KBG). The normal pancreatic structure and islets are clear (→) (c, CG).

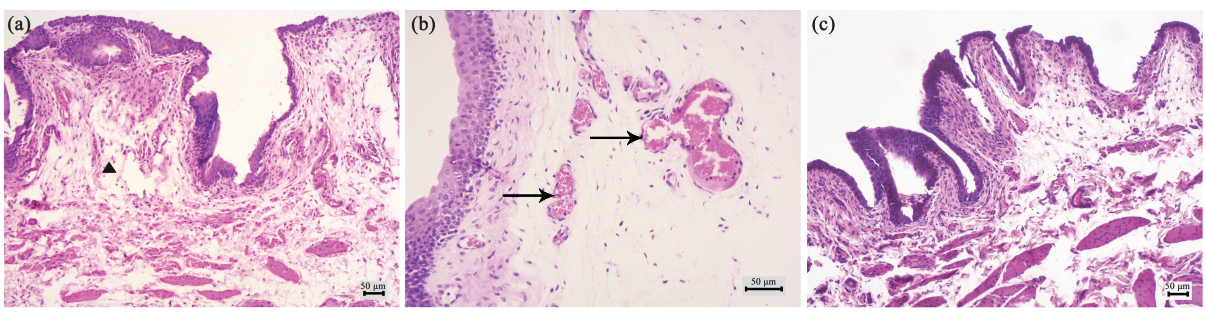

Fig. 10　The bladder tissue in mini-pigs

The bladder lamina is oedematous (▲) (a, SBG) and the bladder submucosa is hyperemia occasionally (→) (b, KBG). The structure of the normal bladder mucosa is clear (c, CG).

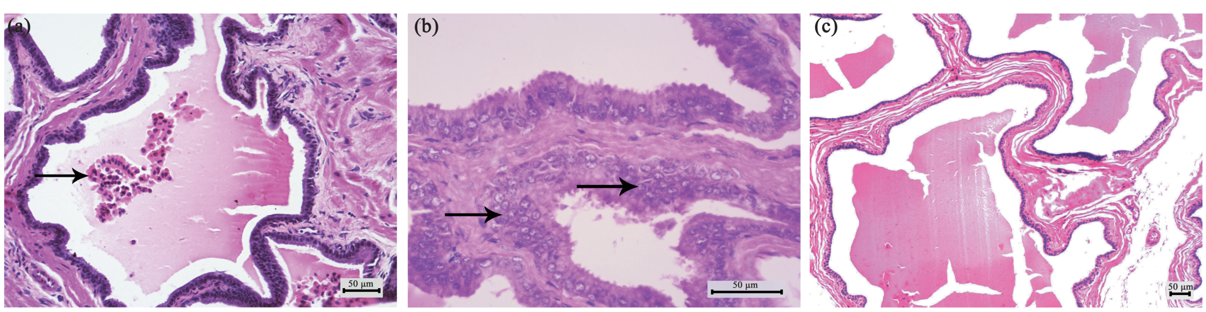

Fig. 11　The prostate tissue in mini-pigs

It has mucous cells shedding (→) (a, SBG) and submucosal hyperemia of the bladder occasionally (→) (b, KBG). The structure of the prostate mucosa is clear and the amount of secretion is normal (c, CG).

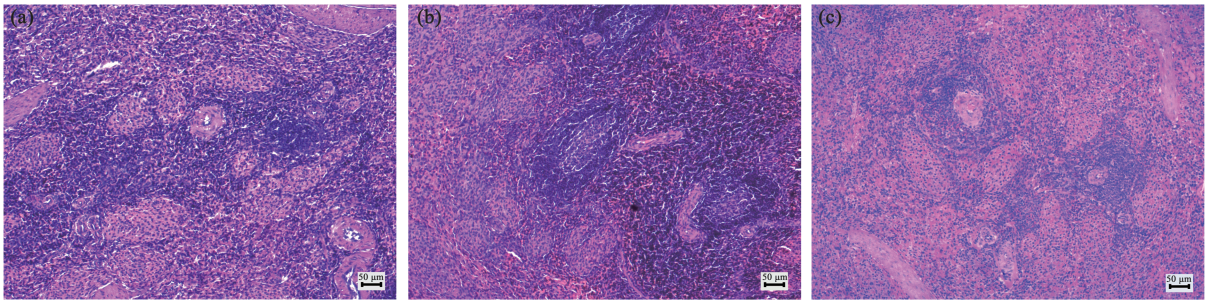

Fig. 12 The spleen tissue in mini-pigs

No obvious abnormalities are found in the spleen capsule, spleen white pulp and spleen red pulp (a, SBG; b, KBG; c, CG).

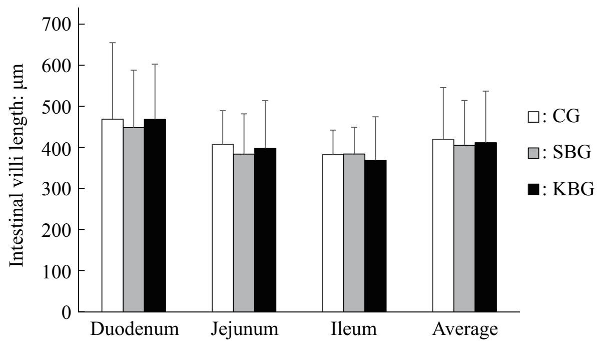

Fig. 13 Length of intestinal villi

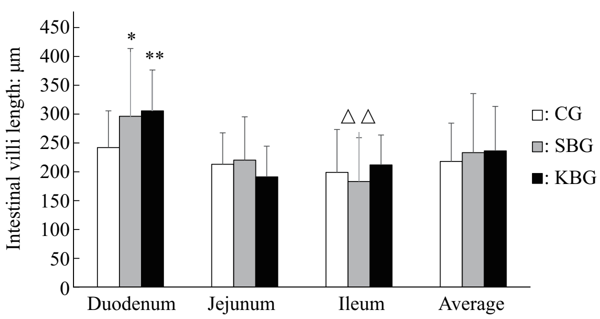

Fig. 14 Intestinal crypt depth

*: P<0.05 *vs*. the CG; **: P<0.01 *vs*. the CG; △△: P<0.01 *vs*. the KBG.

The ratio of duodenal villi length to crypt depth (V/C) in the KBG was significantly lower than that in the CG by 15.74% (P<0.05). The jejunal V/C value in the SBG was significantly lower than that in the KBG by 16.44% (P<0.05). The ileum V/C in the SBG was significantly higher than that in the KBG by 25.91% (P<0.01). The total ratios of small intestine V/C in each group were not statistically significantly different (P>0.05) (Figure 15).

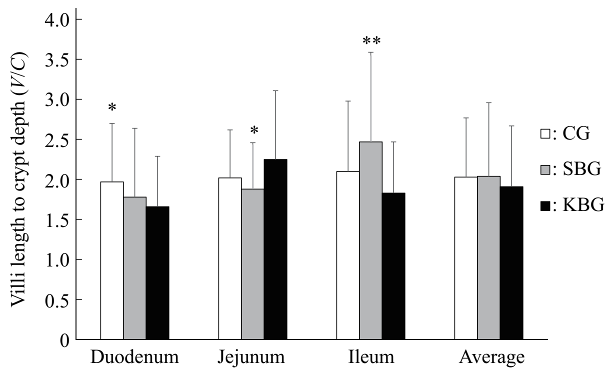

Fig. 15 Ratio of small intestinal villi length to crypt depth

*: P<0.05 *vs*. the KBG; **: P<0.01 *vs*. the KBG.

The colonic mucosal thickness in the SBG and the KBG was significantly larger than that in CG by 53.28% and 68.15% (P<0.01). The total thickness of the colonic mucosa in the SBG was significantly larger than that in the CG by 7.32% (P<0.05). There were no significant differences in the total mucosal thickness between the KBG and the other two groups (P>0.05) (Figure 16).

3.4 Gastrin secretion element （GAS） determination

The results of the positive area of GAS showed that the KBG was significantly higher than the CG (32.82%) and the SBG (28.61%) (P<0.05). There was no significant difference between the SBG and the CG (P>0.05) (Figure 17).

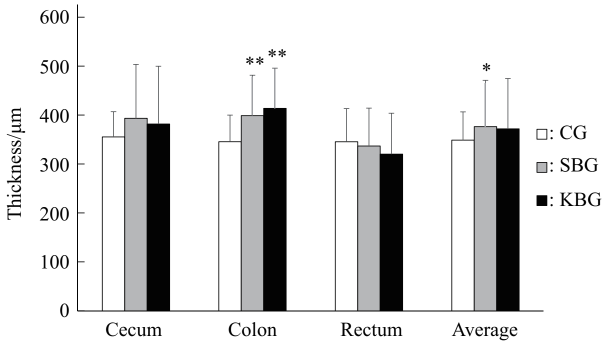

Fig. 16　Thickness of larger intestine mucosa

*: $P<0.05$ *vs*. the CG; **: $P<0.01$ *vs*. the CG.

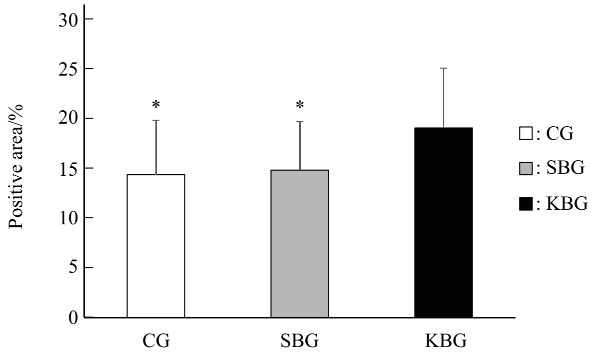

Fig. 17　The positive area of gastrin

*: $P<0.05$ *vs*. the KBG.

4　Discussion

In TCM theory, body surfaces and internal organs can be connected each other by meridians. This is the reason why skin can show the abnormalities of internal organs and why inserting a needle into an acupoint on body surface can cure internal diseases. Based on the experimental meridian study of interstitial fluid channels, meridian is a kind of channel in which interstitial fluid flows more easily than in other tissue. When the channel is blocked, hyperalgesia[7], bloated stomach or/and intestine[8], abnormality of behavior[9] and syndromes of the stomach meridian-gastrointestinal system or kidney meridian-urogenital systems[11] could be induced. To prove these pathological changes, preliminary pathological examinations and morphological observations have been carried out here.

4.1　Effect on the digestive system

The small intestine is an important site for digestion and absorption, and the length of villi, crypt depth and *V*/*C* value of the mucosa are important indexes to measure intestinal function[14]. The *V*/*C* value can comprehensively reflect the functional status of the small intestine, and an increased ratio indicates enhanced digestion and absorption functions[15]. In this study, the function of duodenum and ilum is relatively poor in the KBG because the *V*/*C* value is lower than the CG or the SBG. While the crypt depth is high which means the pigs in the KBG is in a compensated stage. In the SBG, although the jejunal *V*/*C* value is lower than the KBG, the crypt depth of jejunum does not cause it. These findings indicated that the effects on the different parts of intestinal mucosa for blocking the LHRC along the stomach meridian and the kidney meridian are not the same.

The crypt depth in the KBG, which could reflect the rate of mucosal cell formation[15], is extremely higher than that in the CG, suggesting that the intestinal mucosa cells have a higher rate of generation and that the mucosal cells are in an active state. However, the reason for this phenomenon is also related to the high content of gastrin secretion element (GAS). It is well known that GAS produced by the gastric mucosa can act on the intestinal mucosa, which can accelerate the activity of mucosa cells and promote the proliferation of intestinal mucosa cells. Higher GAS in the KBG might be the reason for the extremely significant increase in the crypt depth. And the high level of GAS, which is mainly inactivated in the kidney, is caused by the disorder of kidney in the KBG. There are several reasons for an increasing GAS in the clinic, such as gastrinoma, excessive formation of gastric antrum mucosa and chronic renal failure. In chronic renal failure, the inactivation of GAS by the kidney diseases results in a gastric ulcer. This could also explain why the drinking volume and the urine volume of the KBG are extremely lower than those of the SBG[11].

In several studies, it was found that the content of GAS in the gastric mucosa of patients who have spleen and stomach damp-heat is significantly higher than in normal people or those who have spleen deficiency. The increases in G cells and GAS in the gastric mucosa may be the pathological basis for the syndrome of spleen and stomach damp-heat[16, 17]. In TCM theory, blocking the kidney meridian can causes qi and blood obstruction and weakens the function of the kidney. According to five-element theory in TCM, kidney belongs to water and spleen belongs to earth. As earth can restrict water, the function of the spleen could restrict that of the kidney. When the kidney is weak, the spleen becomes relatively stronger, which explains why the patients with excess syndromes, such as spleen and stomach damp-heat, would result in high levels of GAS. The theory of a "stomach-kidney correlation" in TCM was supported experimentally by the increase of GAS in the KBG.

The colon is the main site for storing food waste, absorbing water, secreting mucus and moving the stool. It had been found that the colonic mucosa of rats with intestinal flora imbalance is thicker than that in the control group[15] and compensatory colonic mucosa became thick after cutting the small intestine[18]. Our results indicated that blocking the LHRC along the stomach meridian and the kidney meridian could thicken the colonic mucosa. This may relate to the influence on the digestion and absorption functions of the small intestine which can induce a compensatory thickening of the large intestine mucosa to maintain normal intestinal function. The total thickness of the colonic mucosa in the SBG was significantly higher than that of the CG which indicated that the effect of blockage on the colonic mucosa thickness is more obvious in the SBG, providing a histological evidence for the low fecal water content in the SBG in our previous study[11].

Apart from the gastrointestinal system, blocking the LHRC along the stomach meridian can also affect liver which is the biggest digestive gland. In TCM theory, spleen and stomach govern digestion and absorption. As stomach meridian belongs to stomach, the stomach meridian has a close relationship with the digestive system. In TCM clinic, pressure point along the stomach meridian can be found in the patients who has digestive system disease because of the disorder in the meridian. Thus, when the stomach meridian was blocked, there were obvious influences on the digestive system. It is also the reason why morphological change of liver appeared after blocking the stomach meridian. Recently, it was proved that *D*-ribose could induce a high level of hepatic triglyceride and leptin in rats[19], we speculated that blocking the stomach meridian might aggravate the influence of *D*-ribose which could be verified in the future.

4.2 Effect on the urogenital system

In human, CRE increases with age during adolescence and tends to stabilize as adults. Therefore, it was normal that CRE increased significantly in our study as mini-pigs grow up. Although the CRE levels of the three groups were all within the reference range, it did not increase normally in the KBG than other two groups. It was found that the CRE value in the KBG was lower than that in the SBG and the CG (by 14.05% and 15.25%) because of the disorder of the renal function which can also be proved by a higher level of urine SG in the KBG. In TCM theory, the kidney is a primary organ which governs the growth. Thus, we speculate that these pathological changes may be due to the influence of the kidney which was originally induced by blocking the LHRC along the kidney meridian. This may also be the reason that CRE in the KBG cannot grow as fast as those in the SBG or the CG.

The kidney is an internal organ of the urinary system in modern medicine. However, the kidney also governs reproduction in TCM theory. Many reproductive diseases are treated through the kidney and the kidney meridian in the clinic. It was found that blocking the LHRC along the kidney meridian could induce morphological changes in the kidney and testis such as the renal tubular epithelial cell necrosis and exfoliation, glomerular endothelial hyperplasia, glomerular sac stenosis and renal interstitial blood vessels expanding within regions of congestion and inflammatory cell infiltration. These results are coincidental to the abnormal examination of blood and urine for renal function, indicating the reason of the pathological and morphological changes is the blockage of the LHRC along the kidney meridian. In the clinic, when a patient has a kidney disease like nephritis, the abnormity can be detected along the kidney meridian by an acupuncturist which is similar to the results in our experiment.

The convoluted tubules are highly coiled epithelial ducts in the testis. The atrophy of the seminiferous tubules leads to the decrease which affects the delivery of sperm to the epididymis. At the same time, the amount of nutrients transported from the boundary membrane to the spermatogenic epithelium is decreasing, which induces a decrease in sperm production. Our experiment showed that atrophy of the convoluted tubules of the testis and less spermatogenic cells at all levels were observed in more than half of the mini-pigs in the KBG. This indicated that the gel blockage of the LHRC along the kidney meridian had a certain effect on the morphology of the testis, which could inhibit the function of the reproductive system. The morphological changes in kidney and testis supported the result of our previous study that the kidney weight index in the KBG was higher than that in the CG and the testis weight index in the KBG was lower than that in the CG and SBG[11].

There were some other indexes showing abnormality. Urine KET were abnormal both in the SBG and the KBG, so that the influence of gel and/or Alcian Blue could not be ruled out. All three groups were positive for occult blood in the urine, which may be caused by puncturing the bladder wall to collect urine. The morphological changes in the heart and lung may be caused during the sacrifice of the animals in this experiment.

This is a preliminary observation to show the pathological changes of internal organs by a long-term blockage of LHRC along meridians. More experiments should be performed specially on the digestive and urogenital systems to study the influences from the blockage of the two meridians.

5 Conclusion

Blocking the LHRC along the stomach meridian can induce the pathological changes in the digestive system, and blocking the LHRC along the kidney meridian can induce the pathological changes in the urogenital system and other changes on digestive system different from that in stomach meridian. Meridian stasis is one of the causes of disease. Blocking different meridian can cause different pathological changes related with the meridian syndromes.

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小型猪胃经与肾经不通模型的病理学比较*

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摘要 前期研究证实在凝胶堵塞循经络的低流阻通道能够降低小型猪模型的痛阈，并引起一系列的行为异常、证候、内脏剖检等变化，本文对这些变化开展了病理学研究. 将小型猪随机分为胃经不通组（SBG，n=8）、肾经不通组（KBG，n=8）和对照组（CG，n=6）. 用凝胶注射法分别堵塞胃经和肾经低流阻通道，饲养7~9周，观察相关指标. 血液肌酐检测结果显示，3组造模后均有增长，但KBG显著低于SBG（13.76%，$P<0.05$）和CG（14.51%，$P<0.01$）. 脏器切片显示，CG的心脏、SBG的肝脏及KBG的肾脏和睾丸半数以上显示异常. 肠切片显示，SBG十二指肠隐窝深度、结肠黏膜及大肠黏膜总厚度较对照组显著增加，空肠V/C值和回肠隐窝深度较KBG显著减小，回肠V/C值较KBG极显著增加. 与对照组比较，KBG十二指肠隐窝深度和结肠黏膜厚度极显著增加. 回肠隐窝深度较SBG极显著增加，胃泌素阳性面密度极显著高于其他两组. 以上结果表明，堵塞胃经或肾经的低流阻通道可以出现不同的病理变化，为进一步研究经脉不通导致的病候群提供科学依据.

关键词 经脉不通，模型，病理变化，胃经，肾经，小型猪
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