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Evaluation of Gastric Motility with Ultrasonography in Conscious Minipigs

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Abstract : The purpose of this study is to evaluate gastric motility of conscious minipigs with ultrasonography from contraction number of the pyloric antrum and gastric emptying time (GET). Five-month-old, clinically healthy minipigs weighing 13.5-15 kg were used for this experiment. Assessment of gastric motility was performed using saline (10 ml/kg) in all five minipigs. Contraction number of the pyloric antrum for 3 minutes and gastric emptying time were calculated. Gastric emptying time was considered to be the time at which the antral area returned to the basal value. The mean value of contraction number of the pyloric antrum before feeding was 1.60 ± 2.30 (mean ± SD) for 3 min and the overall mean value after saline administration was 5.40 ± 3.62 for 3 min. The mean value of GET by area was 58.06 ± 5.23 min. This data can be used as basic database for evaluation of gastric motility in minipigs as normal and various experimental models.

Key words **:** minipigs, gastric emptying time (GET), gastric antrum, ultrasound.

Introduction

To evaluate gastric motility, many studies were performed in veterinary medicine, including radiography using barium and barium-impregnated polyethylene spheres (BIPS®), nuclear medicine, and ultrasonography (1,4,9,10,12,14,16,20). The gastric emptying time were applied to evaluation of gastric functional abnormality, such as pyloric obstruction, post-operating evaluation of surgery of pyloric region, and studies for influence of appetite stimulant, such as diazepam (5,10,21). Recently, studies of gastric emptying for diabetic model of minipigs were reported (17).

The pig is very valuable for biomedical research because the anatomy and physiology of the cardiovascular and digestive systems of pigs and humans are similar (15,22). The problem of size and weight can be overcome by using minipigs (17).

Ultrasonographic method has been widely used to evaluate gastric motility with simplification and noninvasiveness in human and veterinary medicine (2,3,7,19). But there is no report for evaluation of gastric motility with ultrasonography in minipigs. The purpose of this study is to assess gastric motility of conscious minipigs with ultrasonography from contraction number of the pyloric antrum and gastric emptying time (GET).

Materials and Methods

Five experimental minipigs at 20 weeks of age were used in this study. Minipigs were clinically healthy and weighing 13.5 to 15 kg. All minipigs were fasted at least for two days before abdominal ultrasonographic study. From abdominal radiography, empty stomach was found in all experimental animals. Ventrodorsal and slightly right lateral positions were used for ultrasound examination. All minipigs were evaluated for area and contraction number of the pyloric antrum before feeding (resting phase) and after saline administration (10 ml/kg). Contraction number of the pyloric antrum was measured for 3 minutes in every 15 minutes. Gastric emptying time (GET) and gastric emptying rate were calculated by the cross sectional area of the pyloric antrum. Because of difficulties of measuring the pyloric longitudinal diameter in minipigs, area method of Bolondi *et al.*'s (3) method was used only. GET was considered to be the time at which the antral area returned to the basal value (Fig 1).

Results

The mean value (mean ± SD) of the contraction number of the pyloric antrum before feeding was 1.60 ± 2.30 for 3 min, and overall mean value was 5.40 ± 3.62 for 3 min. The value increased after feeding saline (Table 1). The mean value (mean ± SD) of the maximum contraction number of the pyloric antrum was 9.60 ± 2.07 / 3 min at 35.57 ± 10.66 min.

The GET by area increased to its maximum level after feeding saline immediately, then decreased thereafter to its basal value (Table 2). Final emptying time (mean ± SD) calculated according to the changes in the cross-sectional area was 58.06 ± 5.23 min.

Discussion

For obtaining optimal images of the pyloric antrum in dogs,

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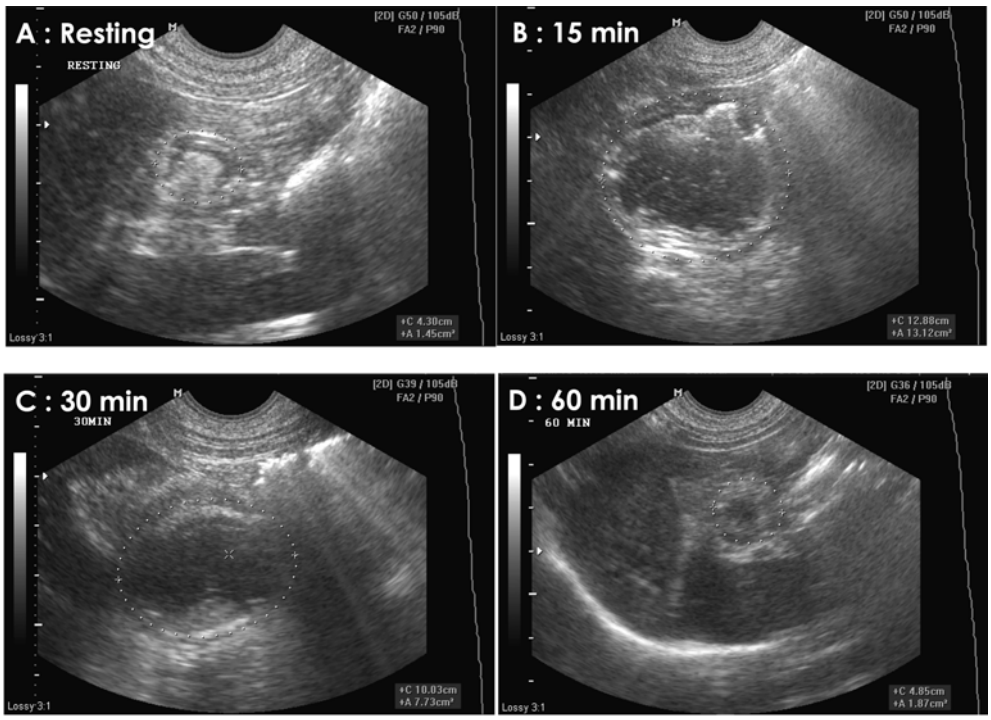
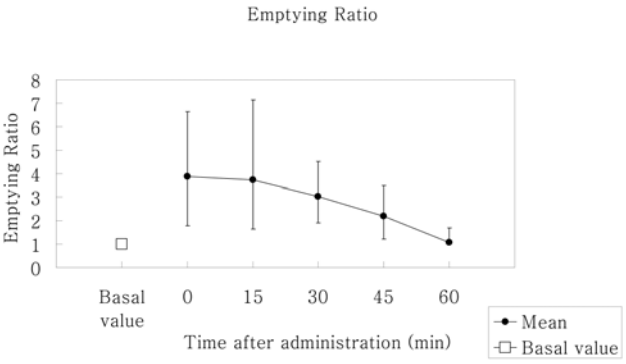


Fig 1. Measurement of pyloric area before feeding (A) and after saline administration (B, C, D). A: Evaluation of gastric antrum area before feeding (resting phase). This was used as the basal value for gastric emptying time. The mean value (mean ± SD) of gastric antral area in resting phase is 2.37 ± 0.79. B: Evaluation of gastric antral area after saline administration at 15 minutes. Anechoic fluid and hyperechoic spots of gas were detected after saline administration. The calculated area included the outer layer of gastric wall. C: Evaluation of gastric antral area after saline administration at 30 minutes. D: Evaluation of gastric antral area after saline administration at 60 minutes. Gastric antral area returned to the basal level at 60 minutes after saline administration.

Table 1. Contraction number of the pyloric antrum before feeding and after saline administration (for 3 minutes)

Factors	Before feeding	After saline administration
Contraction number for 3 minutes (mean ± SD)	1.60 ± 2.30	5.40 ± 3.62

Table 2. Gastric emptying time (GET) in saline-fed group by ultrasonic area method



dorsal recumbency and right lateral oblique positions were used (7,18). In dorsal recumbency, sometimes, the gas in the stomach makes it difficult to see the pylorus. The positional changing to the right lateral position makes it possible to examine the pylorus because of moving the gas into the fundus (3,7). In spite of the anatomical differences of gastric pylorus of pigs, very short curvature side between the cardia and pylorus (8), the scan positions of dorsal recumbency and right lateral oblique were useful in minipigs.

In this study, area method of Bolondi *et al.*'s (3) was used. Because minipigs have short pyloric region (8), it was difficult to measure longitudinal diameter of pylorus and pyloric volume in minipigs. Choi *et al.* reported that although volume method was more accurate, there were no differences between area and volume methods (7).

There are some reports for canine gastric emptying time and gastric emptying ratio by ultrasonograph (6,7,23). Choi *et al.* reported that the GET by area increased to its maximum level after feeding saline immediately, then decreased thereafter to its basal value, in dogs. Final emptying time (mean ± SD) calculated according to the changes in the cross-sectional area of the gastric antrum was 36.73 ± 11.27 min in saline-fed dogs (7). In minipigs, the same result of GET maximum level was obtained. But final emptying time in minipigs was 58.06 ± 5.23 min after saline feeding.

Intragastric volume, particle size, pH, calorie content and osmolarity are all factors which are thought to influence gas-

tric emptying. Many investigations for gastric emptying considered these factors for human and dogs were accomplished (7,11,13,19). Further studies for gastric emptying of minipigs considered various factors, such as intragastirc volume, particle size, calorie contents, are required. These data can be used for the studies of gastric motility in minipigs including normal and various experimental models.

Conclusion

Ultrasonography is a noninvasive and useful method to assess gastric motility in minipigs. In minipigs, area method of Bolondi *et al.*'s can be applied. In this study, the contraction number of gastric pyloric antrum and gastric emptying time before feeding and after saline administration in minipigs were obtained. These data can be used as basic database for evaluation of gastric motility in minipigs as normal and various experimental models.

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초음파를 통한 미니돼지의 위 운동성 평가

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요 약 : 이 연구의 목적은 초음파를 통해 미니돼지의 위 운동성을 평가하는 것이며, 초음파를 통해 측정된 위 유문동의 수축 횟수 및 위 배출시간을 이용하였다. 실험동물은 나이 5개월령, 체중 13.5~15 kg의 건강한 미니돼지 5두를 사용하였으며, 원활한 위 초음파검사를 위해 48시간 절식시켰다. 먼저 공복상태에서 3분간 유문동의 수축 횟수를 측정하였고 유문부의 단면 넓이를 측정하여 이를 기초 값으로 사용하였다. 10 ml/kg의 생리식염수를 먹인 후, 15분 간격으로 3분간 유문동의 수축 횟수를 측정하였고, 각 시간대의 유문부 단면 넓이를 측정하였다. 위 배출시간은 유문부의 단면적이 기초 값으로 돌아올 때까지의 시간으로 하였다. 공복 시 유문동의 평균 수축횟수(평균 ± 표준편차)는 3분간 1.60 ± 2.30 회였고, 생리식염수 급여 후 평균 수축횟수는 3분간 5.40 ± 3.62 회로 측정되었다. 위 배출시간(평균 ± 표준편차)은 평균 58.06 ± 5.23 초를 나타내었다. 이번 실험에서 얻어진 데이터들은 미니돼지의 위 운동성 평가의 기초 데이터베이스로 사용될 수 있으며, 정상 및 여러 질환모델로서의 미니돼지에서 활용될 수 있을 것으로 사료된다.

주요어 : 미니돼지, 위 배출시간, 유문동, 초음파.