

# The Effect of Pelvic Nerve Stimulation on Recto-Anal Motility in the Göttingen Minipig

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**Abstract** - *The aim of the study was to investigate the effect of electrical pelvic nerve stimulation (PNS) on recto-anal motility. The response to PNS was investigated in 8 alpha-1-chloralose anaesthetized pigs. Anal and rectal pressure and rectal cross sectional area (CSA) were recorded by manometry and impedance planimetry, respectively. A new probe design allows measurements of CSA at 5 different locations in the rectum and anal pressure simultaneously. Low intensity PNS (2 times threshold) resulted in a decrease of anal pressure (n=5) and an increase of anal pressure (n=3). High intensity PNS (5 times threshold) resulted in a decrease of anal pressure (n=8). The rectal motility response to PNS showed an increase of CSA near the anal canal and a reduction of CSA in the oral part of the rectum. The results confirms anal motility responses to graded PNS seen in other species. Furthermore, a dual pelvic nerve influence on the rectum was demonstrated with the new probe design*

**Keywords:** Gastrointestinal motility, pelvic nerve, rectum, anus

## 1. Introduction

Prevailing motility of the distal gastrointestinal tract is the result of neurohumeral excitatory and inhibitory inputs. The autonomic nervous system represents the extrinsic innervation of the large bowel and conveys nervous impulses between the central nervous system and the enteric nervous system of the large intestine.

The parasympathetic division of the autonomic nervous system projecting to the rectum and the internal anal sphincter (IAS) originates in the spinal segments S2-S4 in several species including man [11;18;23;25].

In the cat electrical stimulation of the parasympathetic pelvic nerves (PN) causes a sustained contraction of the entire colon and rectum [3;5;7;9;10;17;19].

Moreover, stimulation of the PN in the cat and the opossum elicits IAS relaxation [3;20;21].

In man the information on the parasympathetic influence on recto-anal motility is scarce and mainly

obtained from investigations in patients with defined postoperative or neurological lesions.

Devroede et al [8] and Gunterberg et al [15] reported impaired motility of the left colon and inability to defecate, in patients with bilateral resection of the PN. On the other hand stimulation of the sacral ventral nerve roots S<sub>2</sub>-S<sub>4</sub> in patients with spinal cord injuries induced colorectal contractions [2;22].

The knowledge of parasympathetic influence on recto-anal motility is still incomplete. Therefore, the aim of the study was to establish an acute experimental model in the pig in order to investigate the effect of pelvic nerve stimulation (PNS) on recto-anal motility using a new probe design.

## 2. Methods and Materials

Experimental probe design.

The impedance measuring system was mounted on an 18 cm long, 12-French probe (TensioMED, Hornslet, Denmark). The excitation electrodes were placed with an contact separation of 14 cm. The detection electrodes were placed with an contact separation of 2 mm and a distance between each pair of electrodes of 2 cm. The excitation electrodes were connected to a generator in an impedance planimeter (Gatehouse, Aalborg, Denmark) providing a constant alternating current of 100  $\mu$ A at 10 kHz. The probe and electrodes were covered with a flaccid balloon (14 cm long) made of polyurethane. The balloon was filled and emptied through an infusion channel with electrically conducting fluid (saline 0.018%) and through these channels. Different rectal distension pressures could be applied by changing the level of a waterfilled container (Fig.1). The pressure in the rectal balloon was measured through a 0.7 mm channel. This pressure was defined as the abdominal pressure at rest. The balloon could be inflated to a maximum CSA of 2265 mm<sup>2</sup> (5.4cm in diameter) without stretching the balloon wall.

The anal balloon was made of PVC (4 ml). The balloon had one infusion channel (1 mm in diameter) and 1 channel (0.7 mm in diameter) for measurement of anal pressure (Fig.1).

Records of CSA, rectal pressure and anal pressure were amplified sampled and stored on a computer for later analysis [12].

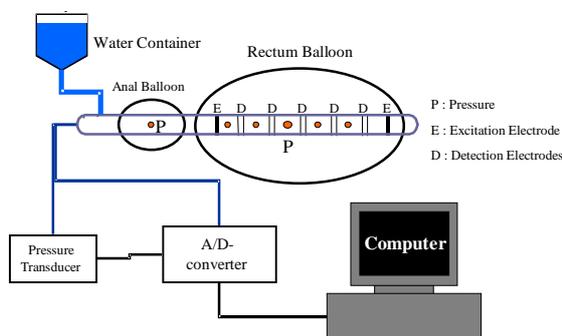


Fig. 1. Schematic illustration of the probe and recording devices.

#### Principles of impedance planimetry measurements.

Impedance planimetry allows simultaneous measurements of intraluminal pressure and CSA of a balloon placed in a luminal organ such as the rectum [6;13;14]. The CSA is measured according to Ohm's law from the measurement of the impedance of fluid inside the balloon [13;16].

#### Surgical procedures.

8 female Göttingen minipigs, fasted for 24 hours and having free access to water, were studied. They were anaesthetized with an iv. bolus injection of Alpha-1-chloralose (62.5 mg/kg, ÅKH, Denmark) after induction with Ketalar (Ketaminol vet.<sup>®</sup>, 5 mg/kg im. Veterinaria AG, Switzerland) and Midazolam (Midazolam, 5 mg/kg im., Dumex Pharma, Oslo, Norge). A tracheal tube was inserted in the trachea to ensure free airways and artificial ventilation was established (40% O<sub>2</sub> and 60% N<sub>2</sub>O, Servo 900, Elema-Schönander, Sweden). The anaesthesia was maintained with Alpha-1-chloralose (38 mg/kg pr hour iv.).

An intra-arterial route for continuous monitoring of blood pressure was established via the right carotid artery. Normal blood gases were documented during the experiments.

The pigs were resting on a heating pad to ensure constant body temperature (esophageal temperature, Cardiomed- CM-4008, Norway). ECG was continuously monitored (Cardiomed- CM-4008, Norway).

The urinary bladder was kept empty to avoid reflex interactions (Rüsch, 12French) [1;4].

The PN were exposed through a dorsal approach as described by Wen JG et al. [24]. After calibration the abdominal pressure was measured using a babyfeed tube.

The probe was gently inserted into the rectum with the small balloon lying in the high pressure zone of the anal canal. The water container was raised to a level 5 cm above the abdominal pressure.

To exclude interference from the external anal sphincter (EAS) on anal pressure, striated muscles including the EAS were paralyzed with Pancuronium (Pavulon, 0.5mg/kg iv.) given every 30 minutes during the experiments.

#### Nerve stimulation.

The PN were dissected free bilaterally (n=7) or unilaterally (n=1) during the initial preparation and provided with cuff electrodes. Graded electrical stimulation with different stimulation parameters was performed using a custom made computer controlled stimulator.

Biphasic square wave pulses were used. At the start of the experiment the stimulation threshold was determined. The threshold was defined, for each nerve, as the lowest current which induced a response. Bilateral stimulation was carried out starting at the current just below threshold for each nerve. In addition the nerves were stimulated at 2, 3 and 5 times threshold at 5 Hz with a constant pulse width of 250 µs. The duration of each train of stimuli was 15s. The pressure in the rectal balloon was set at 5 cm H<sub>2</sub>O above the abdominal pressure.

#### Administration of drugs.

Phentolamine mesylat (Regitine<sup>®</sup>, Ciba-Geigy, Basle, Switzerland) 2mg/kg and Sotalolhydrochlorid (Sotacor<sup>®</sup>, Bristol-Myers Squibb, New York, USA) 1mg/kg were used as selective alpha- and beta-adrenoceptor blocking agents, respectively. Muscarinic and nicotinic cholinergic receptors were blocked by atropine sulphate (Atropin, SAD, Denmark) 1 mg/kg iv. and Hexamethonium (Hexamethonium Bromide Dihydrate, ICN Biomedicals Inc. Ohio, USA) 10 mg/kg. Pancuronium (Pavulon<sup>®</sup>, Organon, Teknika, Holland) 0.5mg/kg iv.

### 3. Results

#### Basal conditions

Arterial blood pressure was 85-150/70-130 mmHg after 30 minutes of equilibration. Resting anal pressure was 36.4± 12.3 cm H<sub>2</sub>O (n=8). Spontaneous variation in CSA was sparse.

The effect of stimulation of the pelvic nerves.

In 8 experiments mean anal pressure was  $39.4 \pm 6.0$  cmH<sub>2</sub>O at 5 cmH<sub>2</sub>O rectal distension pressure. Low intensity PNS (2 times threshold) resulted in a decrease of anal pressure to  $14.7 \pm 5.7$  cmH<sub>2</sub>O (n=5) and an increase of anal pressure to  $12.2 \pm 1.0$  cm H<sub>2</sub>O (n=3). High intensity PNS (5 times threshold) resulted in a decrease of anal pressure in all experiments to  $24.9 \pm 5.6$  cmH<sub>2</sub>O (Top line, Fig.2).

The rectal response to low intensity PNS (2 times threshold, n=6) showed an increase of CSA near the anal canal in 2 experiments (Impedance 5, Fig 2), a decrease in 1 and no response in 3 experiments. High intensity PNS (5 times threshold, n=6) showed an increase of CSA near the anal canal in 4 experiments and a decrease in 2. A decrease in CSA was observed in the proximal part of the rectum in all 6 experiments (Impedance 1, Fig 2) at low as well as at high intensity PNS (Fig.2).

The effects of pharmacological receptor antagonists.

After administration of phentolamine (n=4) a decrease ( $20.4 \pm 2.3$  cm H<sub>2</sub>O) in prevailing anal pressure was seen in all 4 experiments. PNS (3 times threshold, n=4) showed a decrease of anal pressure in 2 pigs, no response in one and an increase of anal pressure in one pig.

The anal pressure was unchanged after administration of Sotacor (n=3). PNS (3 times threshold, n=4) elicited a decrease in anal pressure in two pigs and an increase in one pig.

No change in anal pressure was observed after administration of atropine (n=4). In 3 experiments a decrease in anal pressure was observed after PNS and no response in one pig.

Anal pressure was unchanged after the administration of hexamethonium but responses to PNS were abolished in all 4 experiments.

In the rectum spontaneous activity was augmented after the administration of phentolamine. Addition of Sotacor did not alter spontaneous activity. However, after atropine and hexamethonium spontaneous activity was diminished. Furthermore, all reactions to PNS after hexamethonium was abolished.

#### 4. Conclusions

The results confirmed anal motility responses to graded PNS observed in other species.

The rectal motility response to PNS elicited a reproducible pattern. In the aboral part of the rectum an anal-like response (relaxation) was demonstrated. On the other hand the rectal response in the oral part was of a

colonic type (contraction), suggesting a dual action of the PN on rectal motility.

The Göttingen minipig has proved to be a suitable model for the study of recto-anal motility. The new probe design indicates that the rectal motility response is more differentiated than previously suggested in other studies.

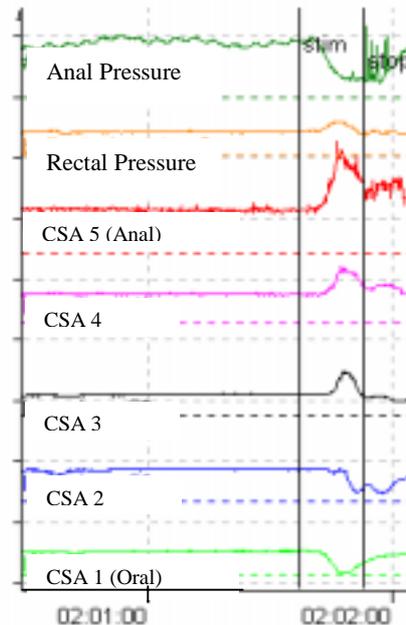


Fig.2. The effects on the recto-anal motility response to PNS (0.4 mA, 5 Hz, 5 cm H<sub>2</sub>O, 15s, PW 250  $\mu$ s). Upward deflection represents an increase in CSA.

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