Functional Monitoring of Small Bowel Motility: Comparison of Spasmolysis Induced by Glucagon or Buscopan

J. M. Froehlich[1], M. Daenzer[1], C. von Weymarn[1], S. M. Erturk[2], C. L. Zollikofer[3], and M. A. Patak[1]

[1]Institute of Radiology, Inselspital, University Hospital, Bern, Switzerland, [2]Dept of Radiology, Sisli Etfal Hospital, Istambul, Turkey, [3]Institute of Radiology, Kantonsspital, Winterthur, Switzerland

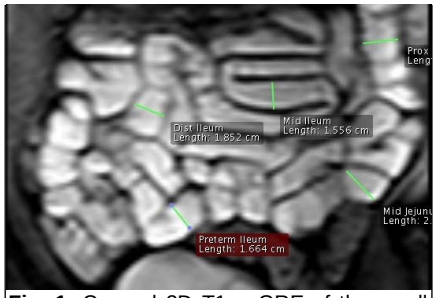

Fig. 1: Coronal 2D T1-w GRE of the small bowel on which the measurement points were defined and propagated.

Purpose:

Peristalsis of the small bowel leads to considerable movement artifacts in MR-examinations, which hamper diagnostic quality [1, 2]. Therefore a spasmolytic premedication agent is commonly administered intravenously to inhibit bowel motion, shortly before performing the abdominal imaging studies. Two main paralyzing agents, hyoscine N-butylbromide (HBB; Buscopan Boehringer Ingelheim, Germany) and glucagon (GlucaGen, Novo Nordisk, Küsnacht, Switzerland) are used in clinical routine to minimize bowel motion. Little has been reported about their pharmacological profile for inhibiting bowel wall motion in cross-sectional imaging. The aim of this prospective clinical volunteer MRI study was to characterize and compare intraindividually the spasmolytic effect on small bowel motility of 40 mg hyoscine HBB vs. 1 mg glucagon both administered intravenously over a time period of 60 minutes.

Material and Methods:

Ten volunteers (5 m, 5 f, mean 32 years) without any known small bowel diseases were included in the study, which had been approved by the hospital's ethical committee. Written informed consent was obtained from all ten volunteers. Preparation consisted of a standardized combination of 20ml Gd-DOTA (Gadoterate, Dotarem, Guerbet, France) and ispaghula fibres (Metamucil, Proctor and Gamble, Ohio, USA) 0.2g/kg body weight, dissolved in 1200ml tap water, which was ingested over a period of two hours prior to the exam.

The study was performed on a 1.5 T MR unit (Intera Achieva, Philips Medical System, Best, The Netherlands), using a 4-channel SENSE phased array body surface coil. Imaging was performed in apnea and in prone position. Monitoring of motility [3] was performed with a coronal 2D T1-weighted gradient-echo sequence: TR 2.7, TE 1.3 ms, flip angle 45°, FOV 500 mm, rectangular FOV 95%, slice thickness 10 mm, matrix 192 x 512, SENSE factor = 2 with a single slice-assessment time of 0.25 s.

First, normal motility was recorded over approximately three minutes repeating the above mentioned sequence with duration of 30 sec in apnea. At the end of the "baseline sequence", either 40 mg of HBB or 1 mg of glucagon were injected intravenously. A 2D sequence was applied with a scanning time of 40 sec, again in apnea followed by a 20 sec break to breathe. Then repeatedly a sequence was performed with a scanning time of 20 sec, followed by a 40 sec pause to breathe, prolonged after 20 min to 100 sec for a total time of 60 min.

For evaluation well distended segments on five different locations (proximal and distal jejunum, proximal, middle and terminal ileum) were chosen (Fig. 1). Measurements were done orthogonally to the long axis of the small bowel resulting in cross-sectional diameters. Measurement locations were defined on the first slice, then propagated through the complete stack and adjusted on each slice in order to correct for displacement. The measurements were plotted over time separately for each volunteer, each drug and for each location (Fig. 2). These plots were evaluated in consensus by two blinded readers for baseline motility frequency, onset time of paralysis, reappearance of the first small bowel motility defining also the time period of complete arrest and finally time delay until motility normalized. The statistical analysis was done using the paired Student's T-test. A p-value < 0.05 was considered to be statistically significant.

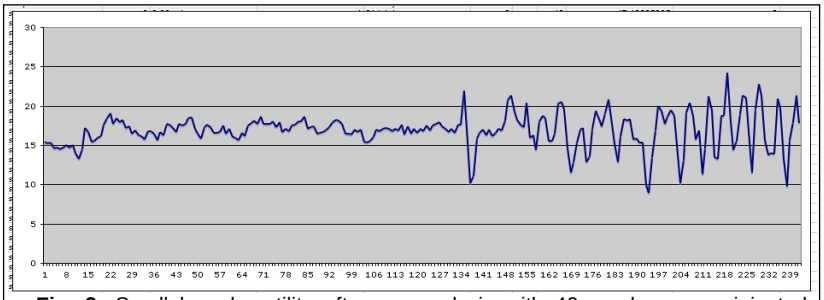

Fig. 2: Small bowel motility after spasmolysis with 40 mg buscopan injected intravenously: Example of a cross-section luminal diameter plotted over time covering 60 min of follow-up. Note the rapid onset of effect and first movements after about 9.8 min with return to normal motility shortly after.

Parameters	HBB (Buscopan®)	Glucagon	p-Value
Baseline frequency [contractions per min]	8.5 ± 2	8.5 ± 1.5	0.91
Onset of effect [sec]	22.2 ± 37.5	13.4 ± 9.2	0.1
First movement [min]	6.8 ± 5.3	18.3 ± 7	**< 0.0001**
Most frequent location of first movement	Jejunum	Terminal ileum	
Delay to normalisation [min]	23 ± 14.9	33 ± 6.1	0.08
Terminal frequency [contractions per min]	9.5 ± 1.7	9.7 ± 1.8	0.45

Tab. 1: Overview of quantitative results with statistical analysis.

Results:

The evaluated baseline frequency of the small bowel contraction showed 8.5 ± 1.75 contractions per minute prior to any drug administration without any differences between the two groups (p=0.91). The mean time-interval between start of injection and paralysis of small bowel motility was 22.2 ± 37.5 s for the HBB group compared to 13.4 ± 9.2 s for glucagon which did not differ statistically (p=0.1). In the HBB group there were only five volunteers achieving a complete arrest of bowel motion, whereas all volunteers had a complete paralysis in the glucagon group (p=0.05). There is also a significant difference for the duration of effect comparing the two drugs. The first reappearing of small bowel motility could be observed in the HBB group after a mean time period of 6.8 ± 5.3 min whereas this occurred only after 18.3 ± 7 min in the glucagon group (p<0.0001). Finally, no significant difference (p=0.08) was measured between the two drugs for the return to normal motility (Tab 1).

Conclusion:

In conclusion, MR is a reliable and reproducible method to assess, quantify and analyze small bowel motility and to demonstrate the effect of spasmolytic drugs on its peristalsis. For the pharmacological evaluation and the resulting imaging consequences, Glucagon seems to be favorable for cross-sectional imaging compared to Buscopan. Both have the same fast onset of effect, but is more reliable with Glucagon. Furtheron with Glucagon, the complete arrest of bowel motion is roughly three times longer than with Buscopan.

References: [1] Marti-Bonmati L et al., Abdom Imaging 1996; 21: 309-13 [2] Wagner M. et al. Acta Radiol 2008; 49: 376-82 [3] Froehlich JM et al., JMRI 2005; 21: 370