Comparison of a novel ingestible gas-sensing capsule with the wireless motility capsule for the assessment of regional gastrointestinal transit in healthy adults

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Background:

Assessment of regional gastrointestinal (GI) transit provides valuable information in diagnosing/subtyping functional GI disorders. It may guide therapeutic choice & monitoring of success. However, it is underused in clinical medicine due to the need for cumbersome imaging techniques with radiation exposure, or the TGA/FDA-approved wireless motility capsule (WMC), for which cost limits access. The novel Atmo™ gas-sensing capsule is a single-use, ingestible device that telemetrically evaluates concentrations of gases and temperature in real-time during transit through the GIT and has the potential to overcome these limitations.

Aims:

Using the WMC as the reference-standard, in healthy subjects, the aims were:

1. To compare the whole-gut transit of the two capsules;
2. To evaluate the gas-sensing capsule for the accuracy of key landmark detection - specifically gastroduodenal (GDJ) and ileocaecal junctions (ICJ);
3. To compare regional transit times;
4. To define interobserver agreement of landmark assessments; and
5. To assess safety and tolerability.

Methods:

Protocol: Following an 8-hour overnight fast, healthy volunteers ingested a standardised cereal bar and then the gas-sensing capsule and WMC in random order with an additional 6-hour fast prior to resuming their habitual diet.

Landmark assessment: Evaluated independently by two observers with a third adjudicator for disparate results.

- *Time=0* was at ingestion and *Final time* was at excretion (defined by temperature drop or signal loss at time of bowel movement).
- *GDJ and ICJ:* For WMC, assessed as per established protocol. For gas-sensing capsule, a 'basic' set of rules was used for the first series of capsules and an 'advanced' set were used for the final 26 studies (using capsule prototype 2.1 with more advanced capabilities).

Analyses: Regional transit times were calculated and compared by Wilcoxon matched-pairs signed rank test and agreement was assessed using Bland-Altman analyses. Intra-class correlation coefficient (ICC) was used to assess inter-observer agreement in the detection of the landmarks identified using the gas-sensing capsule and the WMC.

Results:

Subjects: n=60; 41 male, median age 34 y, BMI 24 kg/m^2.

Useable data were obtained in 58 gas-sensing capsule and 59 WMC studies.

Simultaneous passage of WMC & gas-sensing capsules occurred in 69% (41/59) of studies. Figure 1 depicts paired total transit times for each participant.

Landmark detection:

- GDJ was identified in 53/59 (89%) of WMC and 53/58 (91%) of gas-sensing capsule studies.
- ICJ was identified in 57/59 (97%) of WMC and 55/58 (95%) of gas-sensing capsule studies.

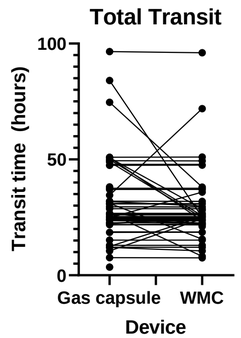

Fig 1. Whole gut transit time

Table 1. Comparison of regional transit times between gas-sensing capsule (prototype 2.1) and WMC (hours, median(IQR)).

Transit region	WMC	Gas-sensing capsule
Gastric emptying time (GET)	2.5 (2.1, 3.5)	2.4 (2.1, 3.4)
Small Bowel Transit Time (SBTT)	4.7 (3.8, 5.2)	4.5 (4.0, 4.8)
Orocaecal Transit Time (OCTT)	7.3 (6.5, 8.3)	6.7 (6.2, 7.7)
Colon Transit Time (CTT)	19.2 (15.5, 25.0)	20.6 (16.1, 30.2)
Whole Gut Transit Time (WGTT)	25.9 (23.8, 35.9)	26.9 (22.3, 37.6)

There was no statistically significant difference between WMC vs gas-sensing capsule transit times (P>0.1 all regions). Transit time was not affected by order of ingestion or patient characteristic (age, height, weight, BMI, smoking status) on univariate analysis.

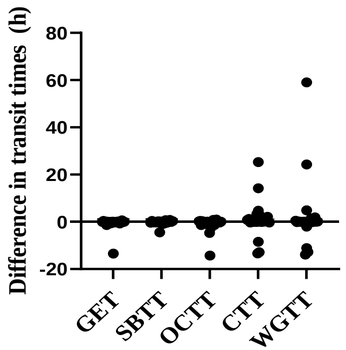

Fig. 2. Paired differences in transit time with the capsule Prototype 2.1 vs WMC (n=26)

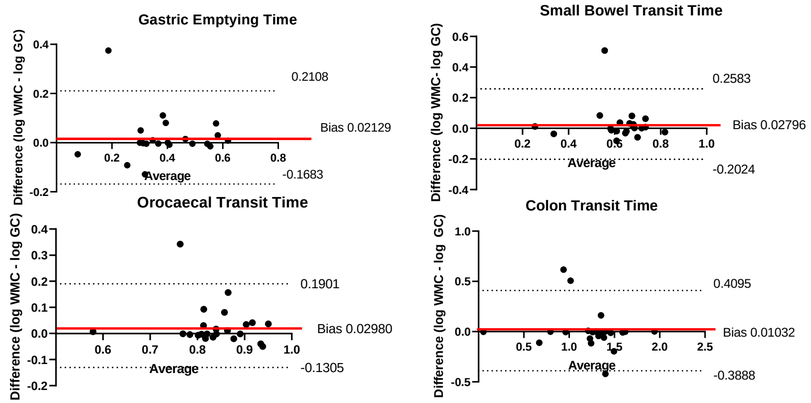

Fig 3. Bland-Altman plots showing good agreement between Prototype 2.1 capsule & WMC

Table 2. Excellent interobserver agreement demonstrated (intra-class correlation coefficient)

	WMC	Gas-sensing capsule (prototype 2.1)
Gastroduodenal junction	1.0	0.99 (0.98-0.99)
Ileocaecal junction	0.98 (0.97-0.99)	0.97 (0.98-0.99)

Safety and tolerability:

- There were no capsule related serious adverse events.
- 11 participants described mild symptoms "possibly" or "probably" related to capsule ingestion.
- 3 abdominal x-rays were performed to confirm excretion of the capsule (n=2 gas-sensing capsule, n=1 WMC).

Conclusions:

The gas-sensing capsule

- **Traverses the gut at a similar rate to the WMC;**
- **Accurately defines landmarks using the 'advanced' set of rules;**
- **Has excellent interobserver agreement in defining landmarks and**
- **Acceptable agreement in assessment of regional transit times; and**
- **Is safe and well-tolerated.**

Automation of landmark assessment would increase clinical utility.

Validation in further populations (healthy and unhealthy) is required.

Conflicts of interest: PG and KB are shareholders in Atmo Biosciences