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Gel stored at low temperature maintains high viscosity even when injected via the water jet channel

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VISCOCLEAR (Otsuka Pharmaceutical Factory, Tokushima, Japan), which is designed for gel immersion endoscopy, has the appropriate viscosity to prevent mixing with blood and/or residue immediately and facilitates securing the visual field during endoscopy [1]. Hiraki, et al. reported that when gel stored at room temperature (25 °C) was injected via the water jet channel using a water pump at the maximum power setting, its viscosity significantly decreased to 321 mPa·s [2], which is close to 231 mPa·s, the lower limit of viscosity required for effectiveness [1]. Hiraki et al. also reported that the viscosity of the gel, which was 768 mPa·s at 25 °C, increased to 998 mPa·s when stored at 4 °C [2].

Therefore, as an additional experiment, we compared the viscosity when gel stored at low temperature (4 °C) was injected via the accessory channel using a BioShield irrigator (STERIS, Mentor, Ohio, United States) with injection via the water jet channel using a water pump (OFP-2, Olympus, Tokyo, Japan) at low to maximum power settings. The EG-580RD endoscope (working length; 1100 mm, accessory channel diameter; 3.2 mm, water jet channel diameter; measured at 1.0 mm, Fujifilm, Tokyo, Japan) was used in this experiment. Data were collected from three independent injections and the mean ± standard deviation determined.

The gel viscosity at 4 °C before injection was 1134 mPa·s. After injection, the gel viscosity decreased using each injection method, with a trade-off between viscosity and flow rate (▶ **Table 1**). Gel stored at 4 °C maintained a high viscosity of 667 mPa·s, sufficient to be effective, even after injection via the water jet channel using a water pump at maximum power setting.

Injecting cold gel with a manual syringe may require more force due to its high viscosity. Previous studies [3–5] reported that cold liquid reduced peristalsis in the esophagus and stomach. Although the effect on the intestine is not clear, the cold gel may reduce peristalsis. Using large volumes of cold gel could possibly lead to systemic hypothermia.

We previously recommended that gel injection via the accessory channel should be the first choice for its effective use, considering the decreased viscosity when injected via the water jet channel. Based on the present results, when injecting gel through the water jet channel using a water pump, we recommend using gel stored at low temperature to maintain sufficient viscosity. When both a high flow rate and high viscosity of gel are required, we recommend injecting gel stored at low temperature through the accessory channel using a water pump.

▶ **Table 1** Changes in flow rate and viscosity after injection of gel stored at 4 °C.

Injection method and water pump settings	Flow rate (mL/min)/viscosity (mPa·s)		
	Low (3/9)[1]	Middle (6/9)[1]	Maximum (9/9)[1]
AC + BSI	170/1015 ± 108	300/882 ± 73.5	520/734 ± 111
WJC	120/915 ± 82.2	170/745 ± 83.2	210/667 ± 76.0

AC, accessory channel; BSI, BioShield irrigator; WJC, water jet channel.
Data were collected from three independent injections and are presented as the mean ± standard deviation.
[1] OPF-2 water pump was set from low (3/9 on the display) to maximum (9/9).

Competing interests

Drs. Yano and Ohata hold patents for and are the inventors of the dedicated gel for the gel immersion method.

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