DIFFERENCES IN THE TEMPERATURE DEPENDENCE OF VISCOSITY IN TWO TYPES OF BARIUM SULPHATE SUSPENSION FOR RADIOLOGICAL USE

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Two types of barium sulphate suspension are in use in upper gastrointestinal radiology: A, the 'classical' type containing hydrocolloids and uniformly small ($\leqslant$ 1μm) particles resistant over long periods to sedimentation (preparation used, Micropaque); B, containing a fraction of large (up to 30μm) particles, little or no hydrocolloid, presented as powder to be dispersed in water immediately before use, and increasingly preferred (James 1978) for the double contrast examination of the stomach (preparation used, X-opaque); sedimentation of large particles readily occurs. Easy flow of a barium sulphate suspension promotes good mucosal coverage and influences the quality of coating, hence the temperature dependence of the flow properties of the administered suspension should be known particularly for type B where extemporaneous preparation is involved. Apparent viscosities were determined for A and B at recommended clinical barium sulphate concentrations (A, 100% w/v; B, 340g + 70ml water) at 16, 25, 30, 35° using a rheogoniometer (cone and plate assembly) at shear rates 0.1 - 1000s^{-1} of which 1 - 100s^{-1} was most relevant.

Table 1. Temperature and shear rate dependence of viscosity of two types of barium sulphate suspension

Shear rate, s^{-1}	Apparent viscosity, poise							
	16°		25°		30°		35°	
	A	B	A	B	A	B	A	B
0.1	17	2500	17	3000	30	850	17	105
1	5.6	308	3.8	215	5.5	86	4.4	7.3
20	1.9	46	1.4	28	1.8	12	1.5	0.6
100	1.2	17	0.9	11	1.1	5.3	1.0	1.0
1000	0.7	3.9	0.5	3.0	0.7	2.2	0.7	1.1

Clearly temperature dependence of apparent viscosity of A was negligible for given shear rates but was observed for B for which, over 16-35°, a 77-times reduction in apparent viscosity at 20s^{-1} occurred, resulting in the lowest apparent viscosity in the range 1-100s^{-1} for A or B. 20s^{-1} could reflect an intragastric shear rate for mucosal flow during the double contrast examination of the stomach. The very low viscosity observed for B at an intermediate rate of shear (20s^{-1}) at stomach temperature could reflect low gum content and would contribute to ease of flow over the mucosa; absence of gum also eliminates one source of structural impedance in the dispersion to large particle sedimentation into the mucosal grooves, believed (Anderson et al 1980) to be a factor in good radiographic imaging of the areae gastricae on which the value of the double contrast examination of the stomach largely depends. Further, the resistance of B to flow which occurred at very low shear rate could contribute to conditions favouring rapid large particle sedimentation into mucosal depressions in which the suspension would tend to accumulate when near-stationary conditions prevail. Despite the high apparent viscosity observed at low shear rates rapid settlement of large particles in B at rest is easily observed in vitro. It seems therefore that for double contrast examination of the stomach barium sulphate preparations of type B should be dispersed in (purified) water and immediately administered at around 35° to ensure best flow over the mucosal surface.

Anderson, W. et al (1980) Brit. J. Radiol., in the press.
James, W.B. (1978) Clinics in Gastroenterology 7: 397-430.