

THERAPEUTIC EFFECTS AND ALPHA-AMYLASE RESISTANCE OF A NEW MIXED STARCH AND XANTHAN GUM THICKENER IN FOUR DIFFERENT PHENOTYPES OF PATIENTS WITH OROPHARYNGEAL DYSPHAGIA

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INTRODUCTION

Oropharyngeal dysphagia (OD) is a prevalent condition among patient phenotypes (older, neurological, post head/neck cancer -HNC-) and leads to severe complications. There is evidence that thickened fluids reduce aspirations; however, the clinical efficacy of thickeners can be affected by salivary α -amylase and vary according to OD patient phenotype.

AIM

To assess the therapeutic effect and α -amylase resistance of a new thickener composed of modified starch, xanthan gum, maltodextrin and modified cellulose (Fresubin Clear Thickener® [FCT], FreseniusKabi) on 4 phenotypes of OD patients.

MATERIAL & METHODS

- We studied 128 patients with OD: G1) 36 older; G2) 31 HNC; G3) 30 Parkinson; and G4) 31 stroke.
- Therapeutic effect of FCT was assessed with videofluoroscopy (VFS) using the Penetration-Aspiration Scale (PAS) for 5 and 20 mL boluses at 4 levels of viscosity (thin liquid, nectar [250mPa·s⁻¹], honey [1000mPa·s⁻¹] and spoon thick [2000mPa·s⁻¹] at a shear rate of 50 s⁻¹).
- The α -amylase effect on each level of viscosity was assessed with a rotational viscometer (HAAKE™ Viscotester™ 550) after 30s oral incubation of 15 mL bolus in the patient's mouth.

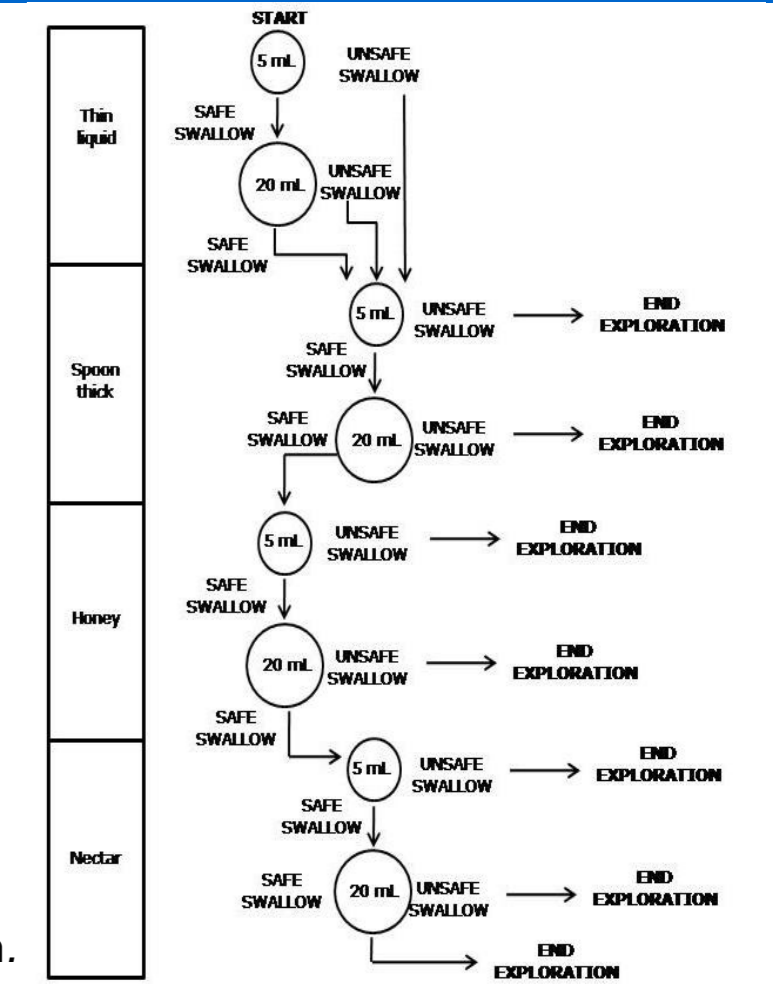


Figure 1. Study algorithm.

RESULTS

1. Demography and VFS characteristics of the study population:

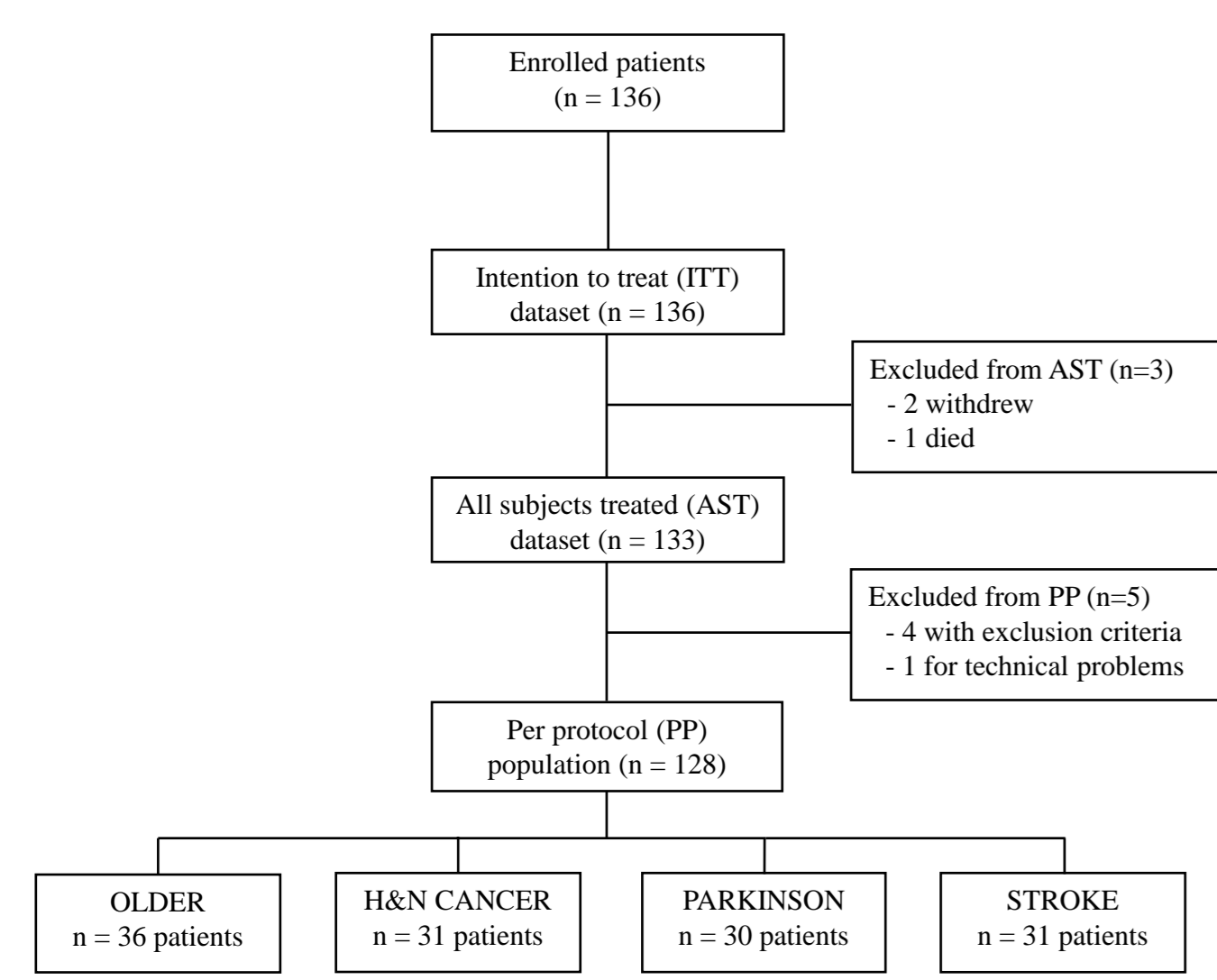


Figure 2. Study flow chart.

Table 1. Demographic characteristics of the study population.

	OLDER	HNC	PARKINSON	STROKE	p-value
N	36	31	30	31	
Age	82.96±7.45	68.29±7.72***	72.34±10.52***	79.42±7.55***	<0.0001
Sex (female) (%)	66.67 (24)	32.26 (10)*	20.00 (6)**	35.48 (11)*	0.0008
Barthel	78.33±25.13	96.50±9.33*	77.33±24.56*	74.83±29.11**	0.0007
Optimum (100) (%)	40 (14)	67.34 (21)*	23.33 (7)**	43.33 (13)	0.005
Sub-optimum (<100) (%)	61.11 (22)	32.26 (10)	76.67 (23)	56.67 (17)	
MNA-sf	10.97±2.29	11.50±1.95	11.7±2.59*	10.6±2.81**	0.326
Well-nourished [12-14] (%)	47.22 (17)	48.57 (17)	60.00 (18)	36.67 (11)	
At risk [8-11] (%)	44.44 (16)	37.14 (13)	33.33 (10)	56.67 (17)	0.610
Malnourished [0-7] (%)	8.33 (3)	2.86 (1)	6.67 (2)	6.67 (2)	
BMI (Kg/m ²)	27.594±5.11	23.97±3.85*	27.50±4.57	27.78±3.93	0.002
Handgrip Force (Kg)	16.33±6.94	22.78±10.60	25.38±9.26*	17.77±7.24*	0.0009
HS self-perception (0-100)	63.57±19.65	70.83±20.00	56.25±20.50*	58.67±28.97	0.055

MNA-SF: mini nutritional assessment short form; BMI: body mass index; HNC: head and neck cancer; HS: health status. * p-value <0.05, ** <0.01 vs. Older; # p-value <0.05, ## <0.01, ### <0.001, #### <0.0001 vs. H&N; † p-value <0.05, †† <0.001 vs. Parkinson.

Global mean PAS

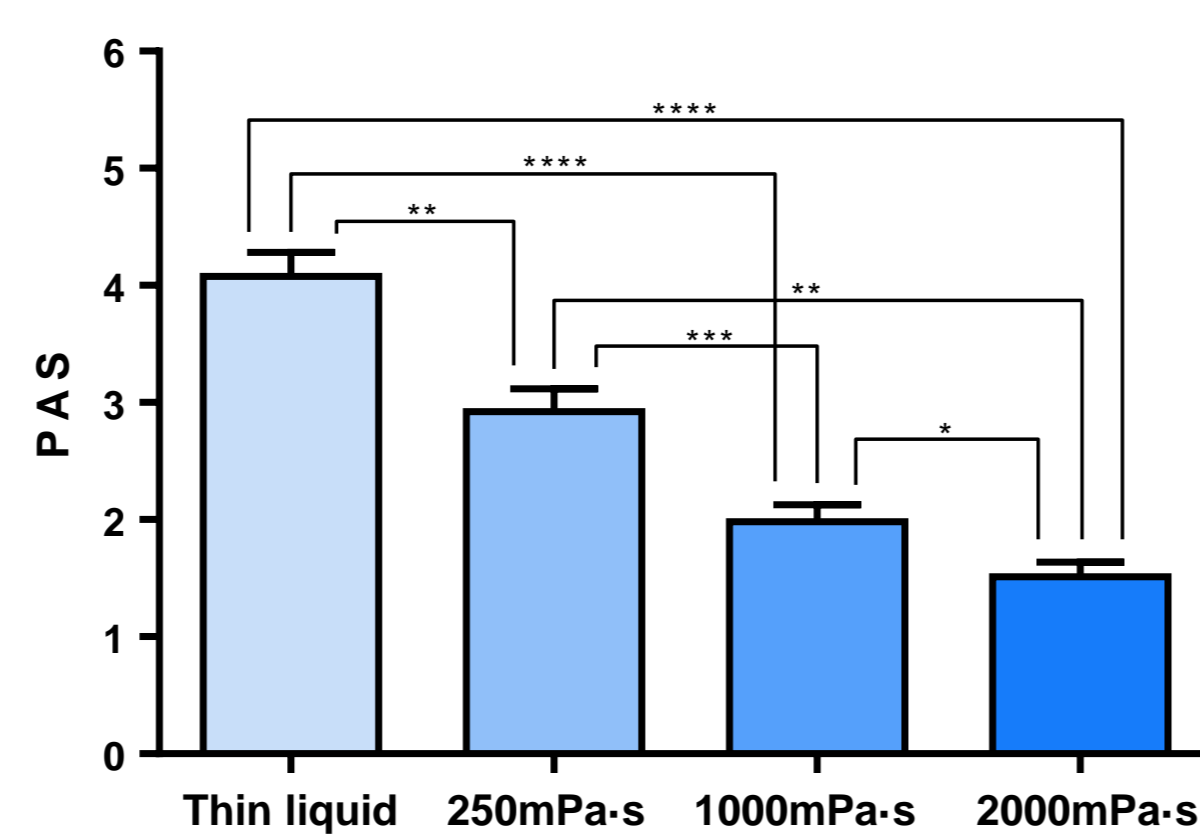


Figure 3. Global mean PAS of the study population. * p-value <0.01, ** <0.0001 vs. liquid; *** p-value <0.001, **** <0.0001 vs. nectar; † p-value <0.05 vs. honey.

Table 2. Videofluoroscopic signs of impaired efficacy and safety of swallow in the study groups.

	OLDER	HNC	PARKINSON	STROKE	p-value
N	36	31	30	31	
Impaired Efficacy (FS/OR/PR) (%)	100.00 (36)	100.00 (31)	100.00 (30)	96.67 (29)	nc
Oral Residue (%)	91.67 (33)	80.65 (31)	76.67 (23)**	61.29 (19)**	0.0002
Pharyngeal Residue (%)	66.67 (24)	96.80 (30)**	86.67 (26)***	74.19 (23)*†	<0.0001
Impaired Safety (%)	63.89 (23)	83.87 (26)	56.67 (17)*	77.42 (24)	0.076
Penetrations (%)	58.3 (21)	74.19 (23)	46.67 (14)*	67.74 (21)	0.135
Aspirations (%)	25.00 (9)	41.94 (13)	13.33 (4)*	35.48 (11)	0.071
Silent Aspiration (PAS=8) (%)	11.11 (4)	25.81 (8)	13.33 (4)	9.67 (3)	0.256
Higher PAS score	4.08±2.31	5.36±2.99	3.80±2.17*	4.55±2.26	0.038

PAS: penetration-aspiration scale; HNC: head and neck cancer; FS: fractional swallow; OR: oral residue; PR: pharyngeal residue. * p-value <0.05, ** <0.01 vs. Older; # p-value <0.05, ## <0.01, ### <0.001, #### <0.0001 vs. H&N; † p-value <0.05, †† <0.001 vs. Parkinson; nc: not calculable.

3. Mechanism of action: LVC was reduced with 1000mPa-s and 2000mPa-s viscosities. The rest of OSR parameters were not affected by FCT (Table 3).

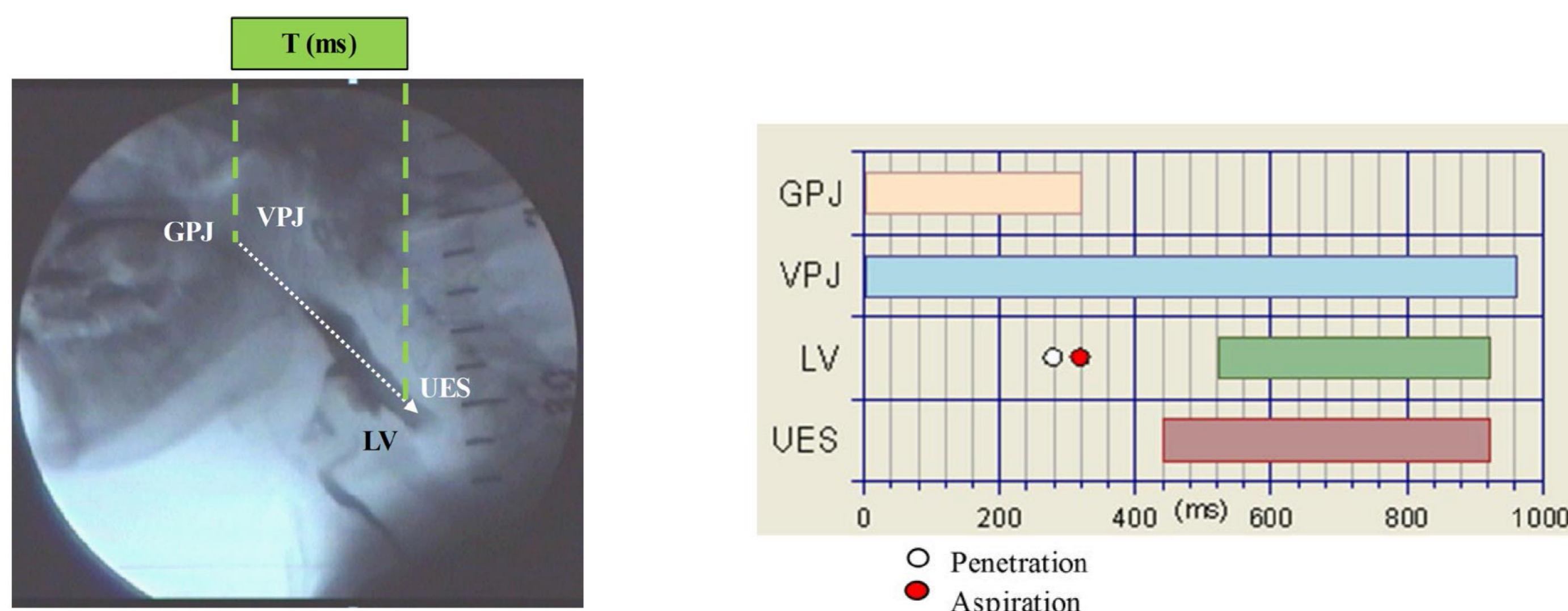


Figure 6. Chronogram of the oropharyngeal swallow response in a patient with thin liquid. All temporal measurements were referenced to glossopalatal junction opening as time 0. The white point depicts time to bolus entering the laryngeal vestibule (penetration) and red point depicts time to bolus passing below the vocal folds (aspiration). T (ms), Time (milliseconds); GPJ, glossopalatal junction; VPJ, velopharyngeal junction; LV, laryngeal vestibule; UES, upper esophageal sphincter.

Table 3. Effect of FCT on oropharyngeal swallow response (OSR) in all study patients.

	Thin liquid	250mPa-s	1000mPa-s	2000mPa-s	p-value
LVC (ms)	387.00±149.50	359.00±125.20	315.80±106.30***	316.20±122.60***	<0.0001
UESO (ms)	259.50±110.3	257.20±101.20	260.00±95.90	290.10±172.90	0.066
Mean bolus vel. (m/s)	0.26±0.11	0.27±0.09	0.27±0.09	0.24±0.12	0.230
Kinetic energy (mJ)	0.96±0.88	0.90±0.69	0.83±0.63	0.85±1.09	0.112
Force (mN)	14.87±11.39	14.43±11.59	13.19±10.81	13.31±15.76	0.228

LVC: laryngeal vestibule closure; UESO: upper esophageal sphincter opening. *** p-value <0.001, **** <0.0001 vs. liquid viscosity; # p-value <0.05, ## <0.01 vs. nectar viscosity.

2. Therapeutic effect: FCT had a strong viscosity-dependent therapeutic effect on safety of swallow in all groups, with a maximal effect at spoon thick, and did not increase pharyngeal residue at any viscosity (Figure 4 and 5).

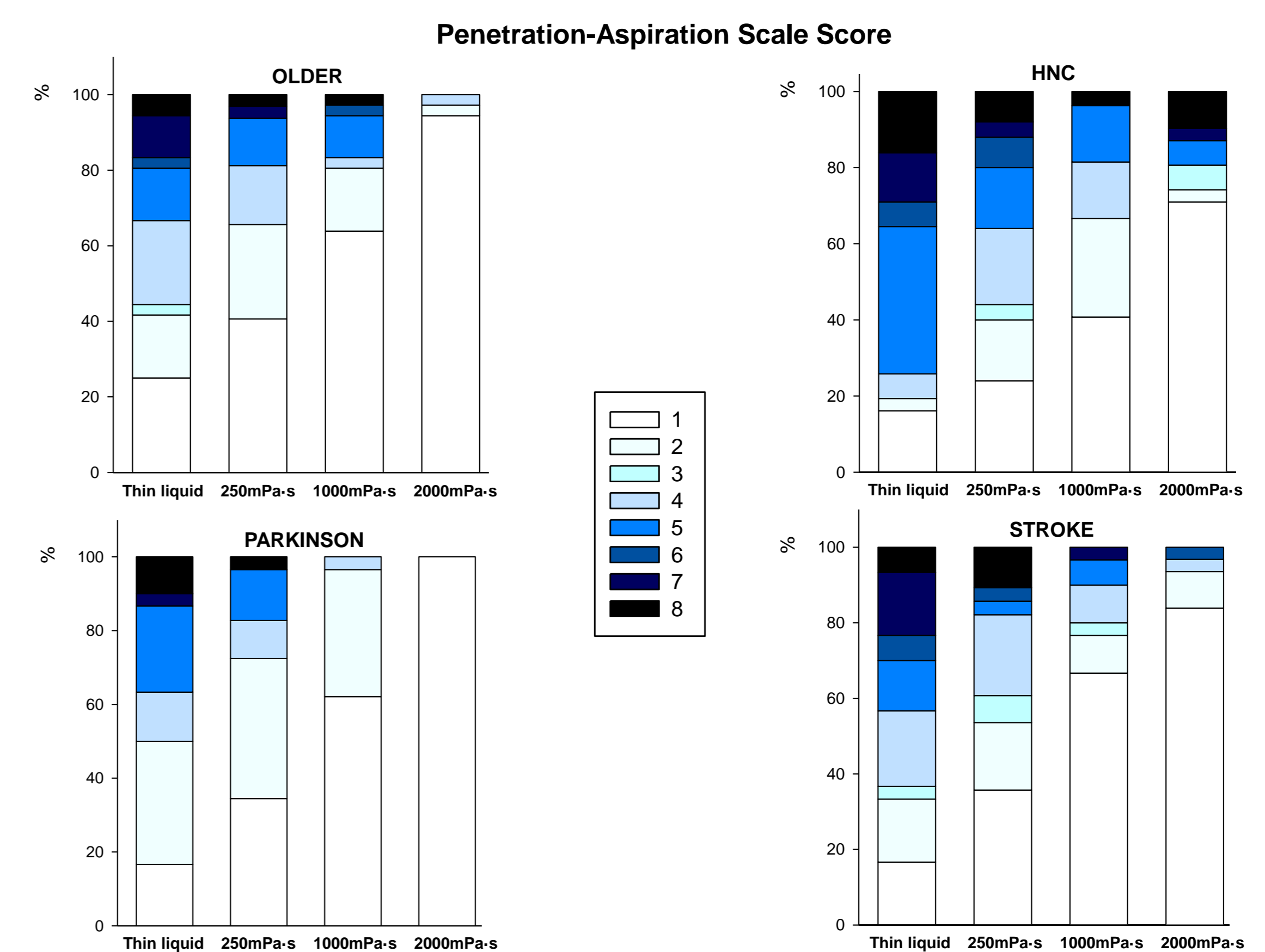
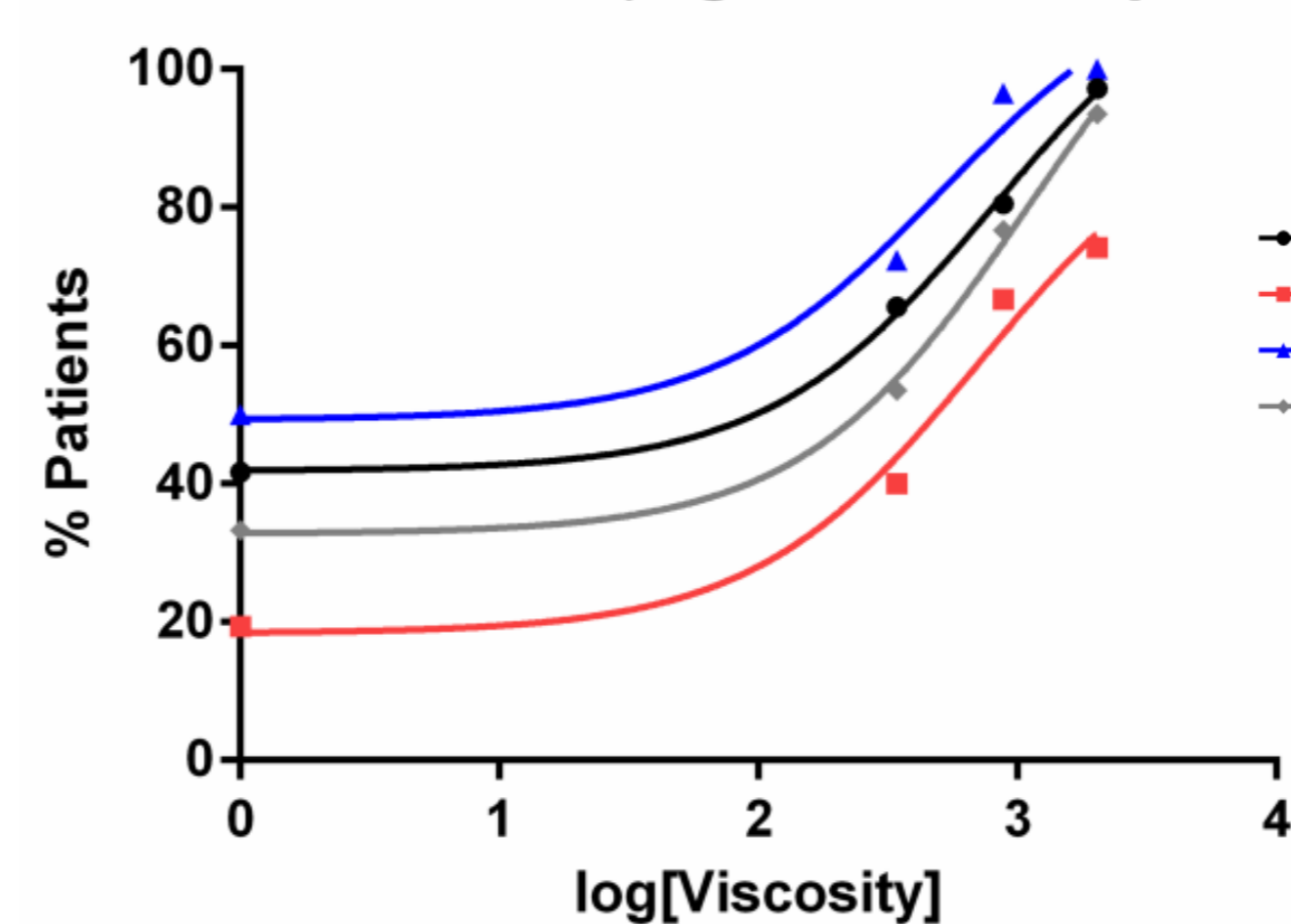
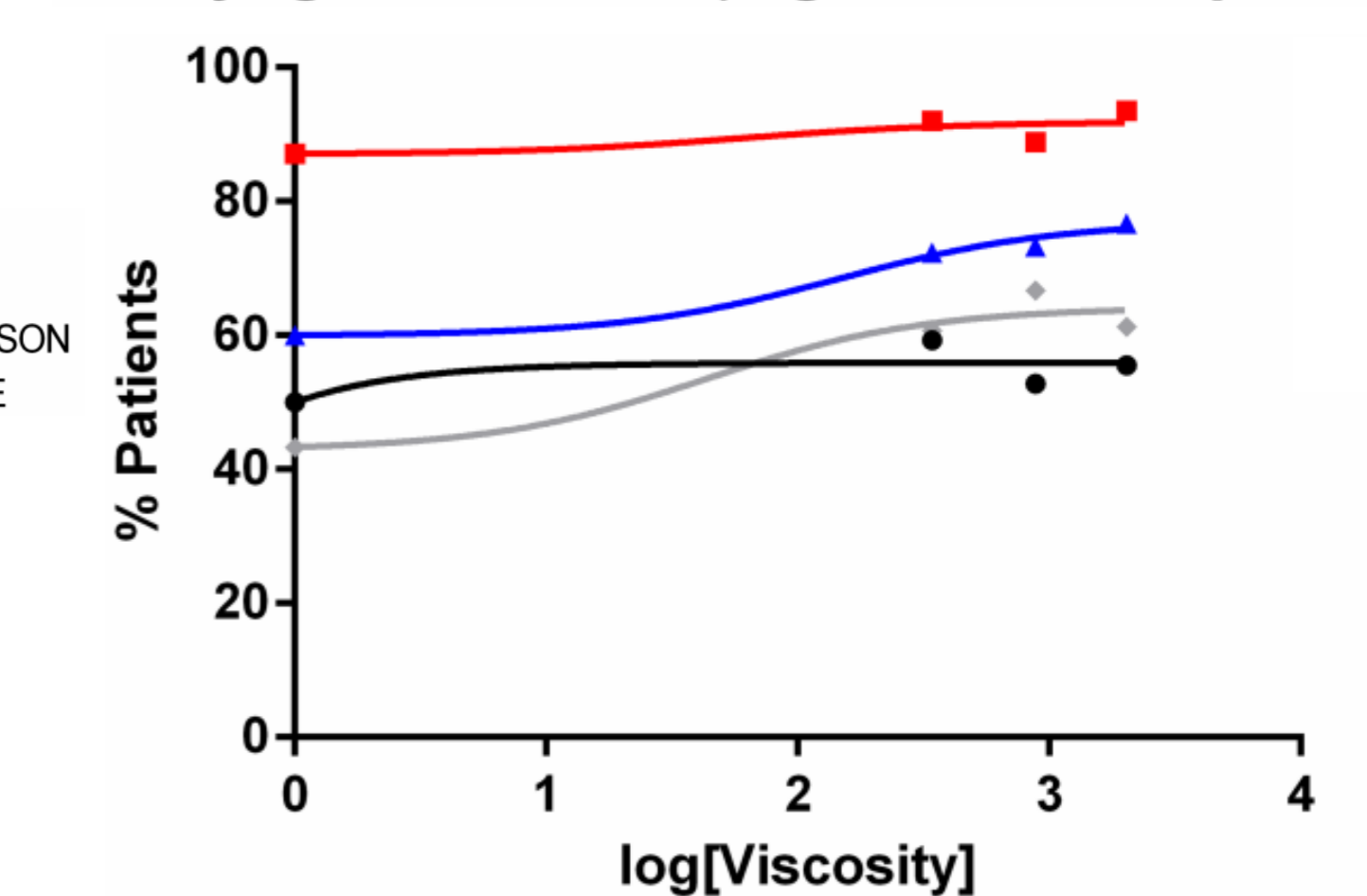


Figure 4. PAS score frequency between viscosities and patients. PAS 1-2: safe swallow and PAS 3-8: unsafe swallow. HNC: head and neck cancer.

Safe Swallow (log-dose vs response)



Pharyngeal Residue (log-dose vs response)



	OLDER	HNC	PARKINSON	STROKE	p-value	Phar. residue	OLDER	HNC	PARKINSON	STROKE	p-value
LIQUID	41.67% (15/36)	19.36% (6/31)	50% (15/30)*	33.33% (10/30)	0.077	LIQUID	50.00% (18/36)	87.10% (27/31)**	60.00% (18/30)*	43.33% (13/30)***	0.002
NECTAR	65.63% (21/32)	40% (10/25)	72.41% (21/29)**	53.57% (15/28)	0.079	NECTAR	59.38% (19/32)	92.00% (23/25)**	72.41% (21/29)	60.71% (17/28)*	0.030
HONEY	80.56% (29/36)	66.70% (18/27)	96.55% (28/29)***	76.67% (23/30)	0.041	HONEY	52.79% (19/36)	88.89% (24/27)**	73.33% (22/30)	66.67% (20/30)	0.021
PUDDING	97.22% (34/36)	74.19% (23/31)*	100% (29/29)***	93.55% (29/31)	0.003	PUDDING	55.56% (20/36)	93.55% (29/31)**	76.67% (23/30)	61.29% (19/31)**	0.003

Figure 5. Effect of viscosity on safety and efficacy of swallow (pharyngeal residue) and multiple comparisons between study populations. HNC: Head and neck cancer. * p-value <0.05, ** <0.01, *** <0.001 vs. Older; # p-value <0.05, ## <0.01, ### <0.001, #### <0.0001 vs. H&N.

4. Amylase effect: The viscosity of FCT was not affected by salivary α -amylase of study patients at any of the viscosity levels tested compared with control samples not incubated with saliva (Figure 7). We also found no differences within patient phenotype groups.

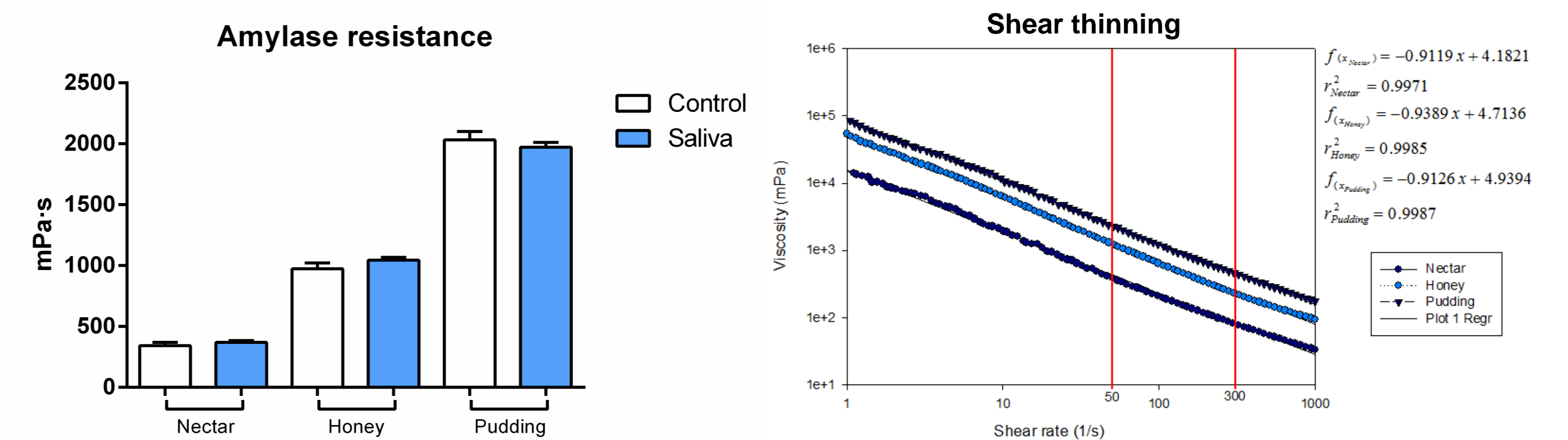


Figure 7. Effect of saliva and shear thinning on viscosity measured with a rotational viscometer.

CONCLUSIONS

- ✓ Increasing bolus viscosity with Fresubin Clear® has a strong viscosity-dependent therapeutic effect by improving safety of swallow with maximal effect at spoon-thick viscosity (2000mPa-s⁻¹) and without increasing pharyngeal residue.

- ✓ The therapeutic effect of FCT is phenotype-dependent, having the strongest therapeutic effect in older patients, Parkinson and stroke and the weakest in HNC.
- ✓ Fresubin Clear® is resistant to salivary α -amylase.