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Rheological properties of impression materials and shark-fin-test: A correlation analysis

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Introduction

Rheological properties are regarded a major influencing factor which influences the accuracy of an impression material. The shark-fin-test has been introduced as a simple test to analyze flow properties of impression materials. However, there is a lack of evidence in the scientific literature on this subject, i.e. no information is available which physical properties or variables are reflected by the shark-fin-test.

Objectives

Thus it was the aim of this study to evaluate potential correlations of the rheological relevant parameters zero shear viscosity and yield stress between results obtained from the shark-fin-test and different rheological properties of elastomeric impression materials after mixing.

Material and Methods

Type 3 viscosities (acc. to ISO 4823) of chemically different impression materials (VPS: Flexitime, hybrid polyether/siloxane: Fusion, polyether: Impregum and P2) (Tab. 1) were subjected to the shark-fin-test (Fig. 1) as well as to two clinically relevant rheological test regimes (zero shear viscosity, yield stress). The rheological tests were conducted at defined 30 s intervals after mixing (n=6) until 150 s using a rotational rheometer (RS 600, Thermo Fisher Scientific) in a plate/plate configuration. All tests were carried out at ambient laboratory conditions (23 °C, 50 % rel. humidity). Median values and interquartile ranges were calculated. For statistical correlation analysis Spearman's Rho was used (α=0.05).

Impression material	Manufacturer	Type
Flexitime Correct Flow	Heraeus Kulzer GmbH, Wehrheim, Germany	Vinylpolysiloxane
Fusion Light Body	GC Dental Products Corp.	Hybrid Polyether/VPS
P2 light	Heraeus Kulzer GmbH, Wehrheim, Germany	Polyether
Impregum Garant L Duosoft	3M ESPE, Seefeld, Germany	Polyether

Tab. 1: Impression materials

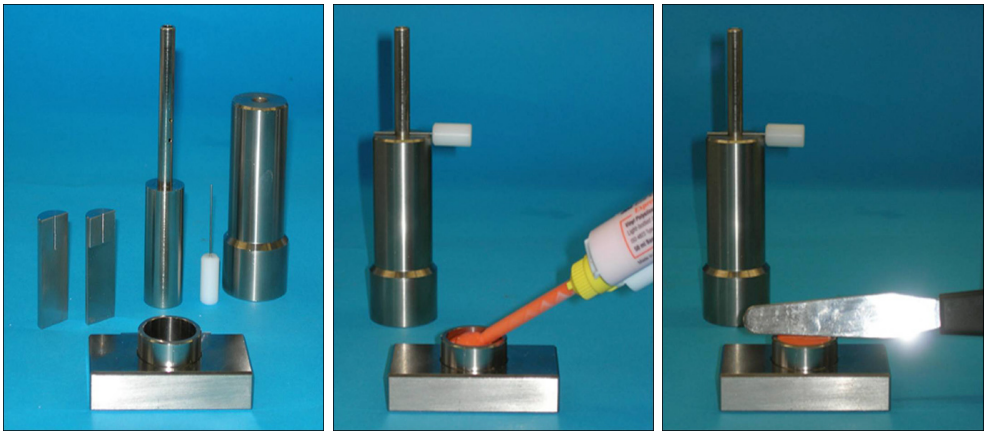

Fig. 1a-c: Procedure while operating the shark-fin-test

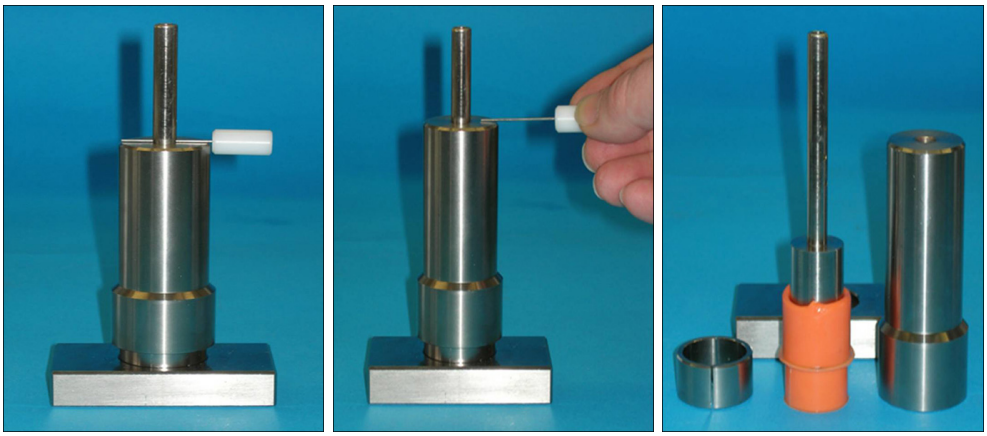

Fig. 1d-f: Procedure while operating the shark-fin-test

Fig. 1g: Procedure while operating the shark-fin-test

Results

Zero shear viscosity was lowest for Impregum at 30 s (321.9 Pa s) and increased for all materials over time. Highest values at 150 s were observed for Fusion (97120 Pa s). Yield stress was lowest for Impregum (17.18 Pa) and decreased over time. In contrast, all other materials showed an increase in yield stress (Fig. 2 and 3). Due to ongoing cross-linking reaction, yield stress could not be determined at progressed points in time for some of the materials.
A significant negative correlation was obvious between the rheological parameters on the one hand and the shark-fin-test on the other ($p < 0.05$).

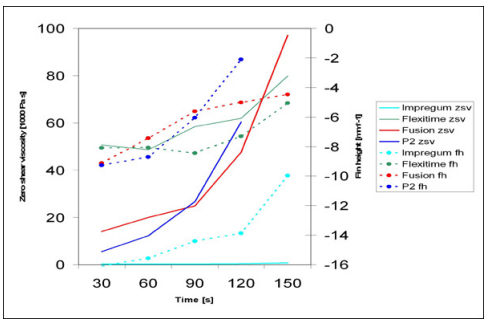

Fig. 2: Zero shear viscosity and fin height of type 3 materials.

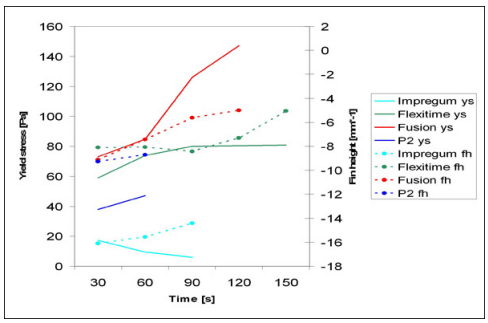

Fig. 3: Yield stress and fin height of type 3 materials.

Conclusions

Zero shear viscosity is affected by the Brownian motion and subsequently may be dependent on filler types and/ or the monomer properties of the impression materials tested. It was significantly negative correlated to the fin heights. Taking into consideration the clinical situation, zero shear viscosity describes the flowability of impression materials.
Yield stress was significantly negative correlated to the shark-fin-test. Chemically secondary bonds have to be resolved by measuring yield stress. The polyethers had by far the lowest values, though their yield stress could not be determined until the end of working time.

Literature

1. Balkenhol M, Wöstmann B, Kanehira M, Finger WJ. Shark fin test and impression quality: a correlation analysis. J Dent 2007; 35 (5):409-415.

2. German MJ, Carrick TE, McCabe JF. Surface detail reproduction of elastomeric impression materials related to rheological properties. Dent Mater 2008;24 (7):951-956.
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Poster Faksimile:

Rheological properties of impression materials and shark-fin-test: A correlation analysis

2882

M. Zenginel, U. Heun, J. Stelzig, M. Balkenhol, B. Wöstmann

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1 Objectives

Rheological properties are regarded a major influencing factor which influences the accuracy of an impression material. The shark-fin-test has been introduced as a simple test to analyze flow properties of impression materials. However, there is a lack of evidence in the scientific literature on this subject, i.e. no information is available which physical properties or variables are reflected by the shark-fin-test. Thus it was the aim of this study to evaluate potential correlations of the rheological relevant parameters zero shear viscosity and yield stress between results obtained from the shark-fin-test and different rheological properties of elastomeric impression materials after mixing.

2 Material and Methods

Type 3 viscosities (acc. to ISO 4823) of chemically different impression materials (VPS: Flexitime, hybrid polyether/siloxane: Fusion, polyether: Impregum and P2) (Tab.1) were subjected to the shark-fin-test (Fig. 1) as well as to two clinically relevant rheological test regimes (zero shear viscosity, yield stress). The rheological tests were conducted at defined 30 s intervals after mixing (n=6) until 150 s [1]using a rotational rheometer [1, 2, 3, 4, 5] (RS 600, Thermo Fisher Scientific) in a plate/plate configuration. All tests were carried out at ambient laboratory conditions (23 °C [6], 50 % rel. humidity). Median values and interquartile ranges were calculated.
For statistical correlation analysis Spearman's Rho was used (α=0.05).

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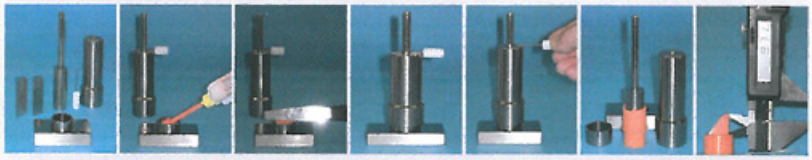

Fig. 1: Procedure while operating the shark-fin-test

3 Results

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A significant negative correlation was obvious between the rheological parameters on the one hand and the shark-fin-test on the other ($p<0.05$).

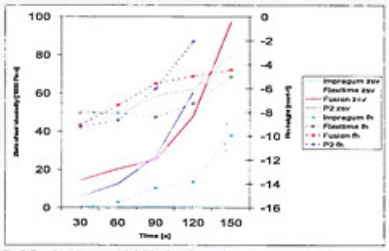

Fig. 2: Zero shear viscosity and fin height of type 3 materials

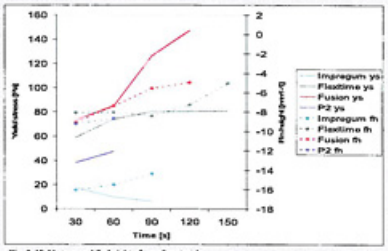

Fig. 3: Yield stress and fin height of type 3 materials

4 Discussion & Conclusion

Zero shear viscosity is affected by the Brownian motion and subsequently may be dependent on filler types and/ or the monomer properties of the impression materials tested. It was significantly negative correlated to the fin heights. Taking into consideration the clinical situation, zero shear viscosity describes the flowability of impression materials.
Yield stress was significantly negative correlated to the shark-fin-test. Chemically secondary bonds have to be resolved by measuring yield stress. The polyethers had by far the lowest values, though their yield stress could not be determined until the end of working time.
Within the limits of the study it can be concluded that the shark-fin-test primarily reflects zero shear viscosity and yield stress of impression materials and might, therefore, be useful to predict flow properties of an impression material during the working time. But it does not fully reflect the setting behavior of impression materials [1].

5 References

1. Balkenhol M, Wostmann B, Kanehira M, Finger WJ. Shark fin test and impression quality: a correlation analysis.J Dent 2007; 35 (5):409-415.
2. German MJ, Carrick TE, McCabe JF. Surface detail reproduction of elastomeric impression materials related to rheological properties. Dent Mater 2008;24 (7):951-956.
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