Tear Strength and Density of set Alginates: Influence of Mixing

K. Orbach*, U. Heun, B. Wöstmann, M. Balkenhol

Department of Prosthodontics, Justus-Liebig-University, Giessen, Germany

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1 Objectives

Alginate is one of the most common impression materials in the world. It has been used in dentistry for over 50 years. But although it has been used as a standard impression material through years there is little information about the mechanical properties of alginates, which decisively influence the quality of an impression [1]. In clinical situations with undercut areas a sufficient tear strength of the impression materials is necessary to prevent ruptures [2]. Material density is an indicator for the porosity of an impression material. Both properties of set alginates reportedly correlate with the quality of mixing [3,4,5].
Hence it was the aim of this study to evaluate the influence of mixing technique and operator experience on the tear strength and density of set alginates.

2 Materials and Methods

Four alginate impression materials (Cavex CA37, Zhermack Hydrogum, GC Aroma fine, Dentsply Blueprint) were either hand mixed or machine mixed by two different groups of operators (dental assistants or undergraduate students). The powder and liquid were previously prepared by a lab technician to warrant a powder liquid ratio as prescribed by the manufacturer. From every operator 80 specimens (4 materials * 2 techniques*10 samples) were obtained. Each group comprised 5 operators thus totalling in 800 specimens. The mixed alginate was placed in a standard mould (fig.1) according to ISO 21563 [7] by one experienced investigator and stored at 35 °C in water for the manufacturers' recommended intraoral setting time. Afterwards the specimens were removed from the mould (fig.2) and tear strength measured in a universal testing machine (Zwick 1454, crosshead speed 400 mm/min) (fig.5a-d). After the tensile test a stripe of 5mm thickness was cut from the fractured specimen and the density was determined using the Archimedic principle in a micro scale (Mettler Toledo Academica XS 205 DU) and a water bath (distilled water) (fig.3,4). Statistical analysis was performed using parametric test procedures to identify the influence of material, mixing technique and operator (α=0.05).

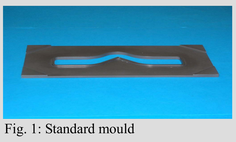


Fig. 1: Standard mould

Fig. 2: specimen preparation

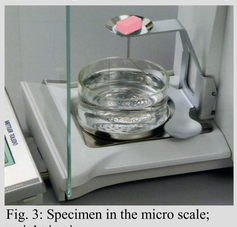


Fig. 3: Specimen in the micro scale; weight in air

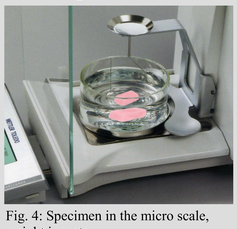
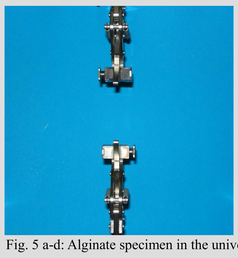
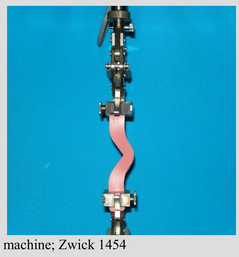
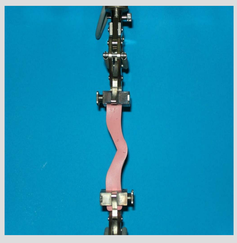


Fig. 4: Specimen in the micro scale, weight in water







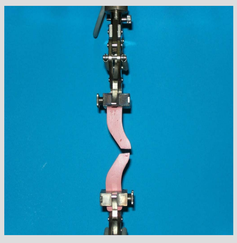


Fig. 5 a-d: Alginate specimen in the universal testing machine; Zwick 1454

3 Results

Tear strength ranged from 0.45 to 0.91 N/mm (fig.6) and density from 1.15 to 1.20 g/mm^3(fig.7). For all materials tested, machine mixing lead to a higher density (significant for all materials, $p<0.05$) and a higher tear strength (significant only for Blueprint, $p<0.05$). CA37 showed significantly higher tear strength values compared to all other materials tested ($p<0.05$). The operator group had no influence on the parameters tested ($p>0.05$).

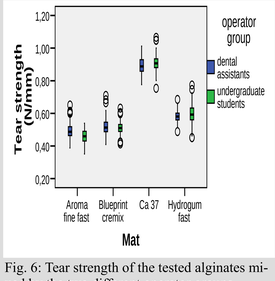


Fig. 6: Tear strength of the tested alginates mixed by the two different operator groups groups

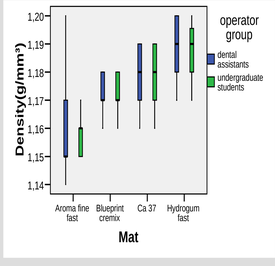


Fig. 7: Density of the tested alginates mixed by the two different operator groups

4 Discussion & Conclusion

Modern alginate impression materials seem to be stable against operators specific mixing influences with regard to tear strength. This is in good accordance with Frey who also reported that the mixing quality of alginate impression materials was not influenced by the operators experience [5]. Consequently it can be concluded that tear strength of alginates is more dependant on the material used than on the mixing procedure applied or the mixing operator.
However our findings clearly point out that mechanical mixed alginates are more dense and thus more "bubble-free" than hand mixed materials [6, 8]. Though it is known that the powder/liquid ratio effects the dimensional accuracy no data are available with regard to the influence of the density on the accuracy at a given powder/liquid ratio. Further studies are needed to analyze the impact of the density of mixed materials on other physical properties especially the dimensional accuracy.

5 References

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6 Correspondence

K. Orbach
Justus-Liebig-University Giessen
Department of Prosthodontics
Schlangenzahl 14, D 35392 Giessen, Germany

Phone: +49-641-99 46 150
Mail: Katharina.A.Orbach@dentist.med.uni-giessen.de
Home: http://www.uniklinikum-giessen.de/proth/

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