

The Effect of Thermoforming on Tear Strength of Ethylene Vinyl Acetate Mouthguard Material in Various Thicknesses

Phakphum Srinuan^{1, a *}, Jeerapatr O. Baiyokvichit¹, Rasana Boonpeng¹,
Tanapol Wongwisatekit¹, Pacharaporn Pattanasukwasan¹,
Irada Karnjanangulpan¹

¹ Faculty of Dental Medicine, Rangsit University, Pathum Thani, 12000, Thailand

^aemail: phakphum.s@rsu.ac.th

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Abstract The effect of thermoforming on the tear strength of ethylene vinyl acetate (EVA) mouthguard material (Bioplast[®]) has not been widely investigated. The present study compared the tear strengths of non-processed and processed EVA specimens in various thicknesses. Two groups of EVA sheet (non-processed and processed) in three different thicknesses of 3, 4 and 5 mm were used in specimen fabrication. The processed EVA sheets were achieved by forming the EVA sheet on the cylindrical stone model with the pressure-molding device (Biostar[®]). Twelve of tear strength specimens of non-processed and processed group in each thickness were prepared following the modified ASTM D 624-00 guideline. The tear strength test was conducted using universal testing machine (Lloyd[®] 1K series) with the speed of 500 mm/min. The mean thickness and tear strength of the non-processed and processed specimens in each thickness were compared using independent T-test. The differences in the mean tear strength for each thickness of non-processed and process specimens were determined using one-way ANOVA. The mean tear strength and mean thickness of processed EVA specimens was significantly lower than the non-processed EVA specimens for every thickness ($P \leq 0.05$). There was no significant difference in the mean tear strength of EVA specimens among each thickness in both non-processed and processed groups. It can be concluded that the thermoforming process has the significant effect on the tear strength of the EVA mouthguard material formed by pressure molding device in every thicknesses. The tear strength of processed specimens were significant lower than the non-processed. Thus, it is more relevant for testing properties of the processed mouthguard material that the mouthguard material before processing.

Introduction

Mouthguard is a removable dental prosthesis made of resilient material which is useful in protecting the teeth and surrounding structures from injuries [1]. It has been recommended by the American dental association to use the mouthguard in 29 sports/exercise activities [2]. Mouthguard can be classified in three categories; custom-made, mouth formed, and stock type [3-5]. The custom made mouthguard has been proved for the superior benefit in dental and oral structure protection due to its fit and adaptation to the oral structure. However, it requires complicated fabrication procedure [4, 5]. The custom made mouthguard can be fabricated in two methods: vacuum-forming process and pressure-forming process [5-7]. The pressure-forming process has been reported to produce the superior mouthgurad product because the manufacturer can control the heat and pressure resulting in less thickness reduction [6, 7]. Currently, the widely used materials for mouthguard fabrication are ethylene vinyl acetate (EVA) copolymer [8]. There have been a number of studies about the physical and mechanical properties of mouthguard material including energy absorption, hardness, elasticity, water absorption, and tear strength properties. However, most of those studies focused on the mouthguard material sheet before thermoforming that may be less relevant for clinical application [8].

The changing in the physical and mechanical properties of mouthguard material after thermo-forming has been reported in many studies during the past decades. Most of those studies