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Original Research Article

The efficacy of silk fibroin on compressive strength of mineral trioxide aggregate

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Abstract: Despite its favorable properties, MTA presents some shortcomings like long setting time. The aim of the study is to evaluate the efficacy of silk fibroin on compressive strength of MTA. Twelve packs of MTA (produtos Odontologicus Angelus industrial), soluble silk fibroin (2gr) and distilled water (2ml), respectively, were mixed to a ratio of 3:1. Every mixing was placed in a stainless steel cylindrical container with an inner diameter of 4 mm and a height of 6 mm for setting and incubated at 37°C and humidity of 95%. The most of the force required to break for each specimen was considered as compressive strength (compressive strength). The broken sample was evaluated under an electron microscope (SEM) and the changes in surface topography were studied for case samples and control samples. There were significant differences between two groups after one day and after seven days. Also, there were significantly different after seven days versus after one day for case control. Therefore, the MTA was more after one day and seven days in the control group compared with case samples and also was more after seven days versus one day in case samples. In conclusion, the solution of silk fibroin (2%) was no effective on the compressive strength of MTA, although there was no the difference in the compressive strength between two groups in 7th day.
Keywords: Mineral trioxide aggregate, Compressive strength, Silk fibroin

INTRODUCTION

Mineral trioxide aggregate (MTA) is composed of Portland cement, with 4:1 addition of bismuth oxide added so that the material can be detected on a radiograph [1]. MTA was developed at Loma Linda University, in the 1990s, as a root-end filling material [2]. The addition of a water-soluble polymer to the MTA, which to date has been used primarily to seal lateral root perforations and as a root-end filling material, resulted in material that is suitable for use as an endodontic sealer [3]. Despite its favorable properties, MTA presents some shortcomings like long setting time [4]. A shorter setting time would be beneficial because it would allow less time for contaminants in the oral environment to adversely affect the material, allow safer placement of restorative material over it (pulp capping), and also shorten the period when the washout of cement can occur [5]. The aim of the study is to evaluate the efficacy of silk fibroin on compressive strength of MTA.

MATERIALS AND METHODS

In this study, 12 packs of MTA (produtos Odontologicus Angelus industrial), soluble silk fibroin (2gr) and distilled water (2ml), respectively, were prepared that after mixing to a ratio of 3:1 (according to the manufacturer's recommendations, i.e. one gram MTA mixed with 0.34mg liquid) were placed in a stainless steel cylindrical container with an inner diameter of 4 mm and a height of 6 mm for setting and incubated at 37°C and humidity of 95% [6]. Six case samples, including 6 packs of MTA (6gr) and silk fibroin (2gr) placed in 6 stainless steel cylindrical containers and divided into two categories T1 and T2, respectively. Six control samples, including 6 packs of MTA (6gr) and distilled water (2ml) placed in six stainless steel cylindrical containers and divided into two categories C1 and C2, respectively. T1 included three samples MTA mixed with a solution of silk fibroin(2%) that after one day removed from the chamber and by mechanical device Universal (SANTAM, STM-1, Iran) was done a compressive stress test and T2 which contained 3 samples MTA mixed with a solution of silk fibroin(2%) after 7 days tested [7]. The most of the force required to break for each specimen was considered as compressive strength (compressive strength). C1 included three samples MTA mixed with distilled water that after one day

removed from the chamber and by mechanical device Universal (SANTAM, STM-1, Iran) was done a compressive stress test and C2 which contained 3 samples MTA mixed with distilled water after 7 days tested**.** The broken sample was evaluated under an electron microscope (SEM) and the changes in surface topography were studied for case samples (**Figure 1**) and control samples.

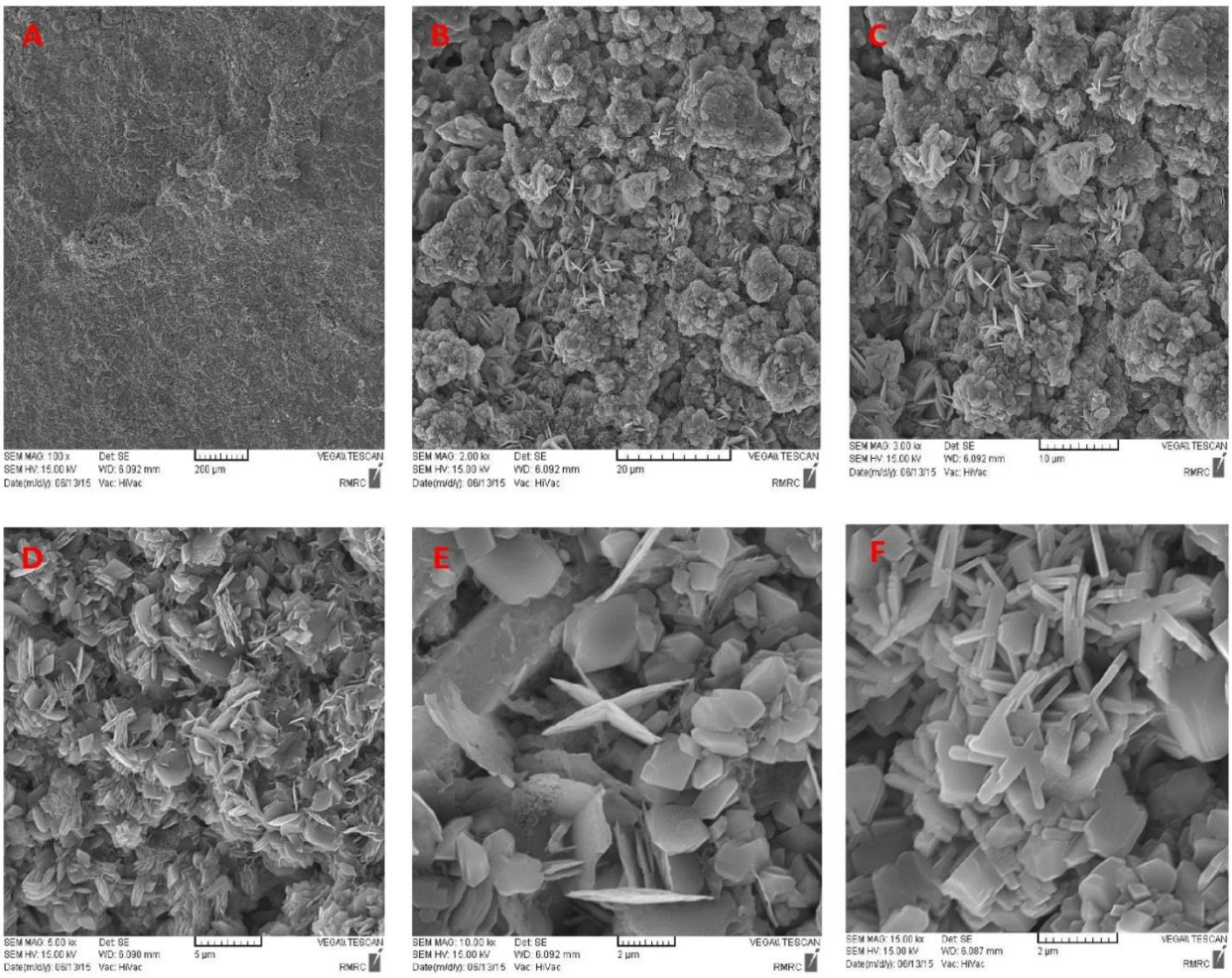

Fig 1: SEM images of the fractured surfaces of the sample (MTA and Silk fibroin) after seven days (magnification, A:×100, B:×200, C:×300, D:×500, E:×1000, F:×1500)

STATISTICAL ANALYSIS

The data were analyzed with SPSS version 18 software. Independent samples T-test was used for the correlation between data. P<0.05 was considered statistically significant**.**

RESULTS

MTA in the two groups has been shown in **Table 1.** There were significant differences between two groups after one day (P=0.017) and after seven days (P=0.049). Also, there were significantly different after seven days versus after one day for case control (P=0.017). Therefore, the MTA was more after one day and seven days in the control group compared with case samples and also was more after seven days versus one day in case samples (P<0.05).

Table 1: The amount of MTA with two solutions after one day and seven days

Samples	**After one day**	**After seven days**	P(95%CI)
Control	23.7±4.3	25.7±3.4	0.459(-17.06,6.73)
Case	6.9±1.0	16.8±4.3	0.017(-17.06,-2.90)
P(95%CI)	0.017(6.77,26.83)	0.049(0.078,17.70)	

DISCUSSION

This study shows the efficacy of silk fibroin on compressive strength of MTA. Important limitations of mineral trioxide aggregate for use in clinical procedures, are extended setting time and difficult handling characteristics [8]. MTA fulfills many of the

ideal properties of a root-end filling material. However, the composition of this material often makes MTA difficult to use, a direct result of its granular consistency, slow setting time, and initial looseness [5]. MTA has been widely used in all fields of Endodontics. One of the major drawbacks of this material is the longer setting time. With the addition of 8% and 10% of nano-SiO2 to the MTA, the setting time of both mixtures decreased significantly. However, the compressive strength (after 1 day and 1 week) and flexural strength increased; this was not significant [9]. Delayed setting times may limit the use of MTA in endodontic procedures. The setting times were evaluated using a Vicat apparatus; compressive strengths of set materials were evaluated with an Instron machine. NaOCl gel, K-Y Jelly and 5% CaCl2 decreased the setting time to 20 to 25 min; compressive strengths of these set materials were significantly lower than MTA mixed with water ($P<0.05$) [10]. Basturk *et al.;* [7] reported that specimens mixed with the 0.34 water-to-powder (WP) ratio had higher compressive strength values (72.85 ± 25.77) than those mixed with the 0.40 WP ratio (56.69 ± 24.85) ($P<0.05$). Arruda *et al.;* [11] showed that replacing distilled water with two biologically active mixing agents (doxycycline and chlorhexidine) did not alter the sealing properties of MTA. One study on 4 groups (Group 1 (Control) was obtained by mixing MTA with distilled water, Groups 2 and 3, MTA containing 10% CaCl2 and 20% CaF, respectively, was mixed with distilled water and Group 4, MTA was mixed with 15% Na2HPO4) [12], concluded that the setting time of test groups was significantly shorter than that of control group ($P<0.001$). The compressive strengths of test groups were lower than that of control group ($P<0.001$). Study results showed that additives significantly reduced the setting time of MTA. However, there was not much improvement in the compressive strength of the material. In this study like to other studies, the setting time was caused increasing in compressive strength of MTA, both in distilled water and the solution of silk fibroin (2%). In addition to, rate of compressive strength of MTA was more in the solution of silk fibroin (2%) compared with distilled water as in the first day, the compressive strength in distilled water was very high ($P<0.05$), but in the 7^{th} day, the difference between the two groups became near ($P>0.05$).

CONCLUSION

The solution of silk fibroin (2%) was no effective on the compressive strength of MTA, although there was no the difference in the compressive strength between two groups in 7^{th} day.

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