Determination of the expansion magnitude of some types of plasters

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ABSTRACT

The dental prosthesis is a natural device for the re-establishment of the patients' functional normality in the absence of teeth. However, it is necessary to control the possible in adjusts of the prosthesis, mainly the alterations of the materials used during the making of those; the property of the dental plasters for example. This work focuses on the calculation of the magnitude of the expansion of some types of plaster and the comparison of the data of the normal setting expansion as stated by the manufacturers with the data of the specifications # 25 of ADA (1981). For this investigation 3 types of dental plasters were used, type III (Mossoró), IV (Densite), V (Exadur). A ring of flexible rubber and an expansion meter clock (Mitutoyo - Absolute, in/mm). They were used for menstruation Ten samples of each material were obtained and after 2 hours of the spatulation each one was measured with electronic pachymeter (STARRET) and we obtained the total expansion individually. After we applied the test of Kruskal Wallis at 5% of significant results showed, mainly with the plaster Mossoró, that there was a difference when compared with the expansion supplied by the manufacturers. This way, it does not meet the specification # 25 of ADA (1981).

Key Words: plaster, expansion, dental materials, stone gypsum.

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INTRODUCTION

For a long time prosthesis have been used to restore the normal functionality of edentulous patients. For that, it is important to control

the alterations in the dimensions on materials used to produce these prosthesis, mainly in relation to dental plaster molds. It is obvious that the working model should be closer to the actual dimension of the tooth, since the prosthesis will be constructed upon this mold.

Dental plaster is used in dentistry in many instances. There are many types, some of them used for molding (type I), other for study molding (type II) or working models (type III, IV, V) upon which the dental prosthesis are made. Some plasters, with silica mixture, are used as inlay for casting metallic structures.

According to Motta et al. (1986) plaster has been used in dentistry since the XVIII century as models or molding material, showing structural modification that gradually granted better quality to the product (Bonachela, 1991)

Many authors have shown concern with the influence of the technique of plaster preparation regarding its properties. Coleman (1928) presents one of the first papers on setting expansion using the system standardized by the American Dental Association (ADA, 1972). Many other authors have contributed in this connection (Volland & Paffenbarger, 1932; Kimbaall, 1934; Studervant, 1937; Docking, 1968; Peyton, 1964; Skinner & Phillis, 1967; Phillips ET al., 1969; Lindquist ET al., 1953; Nolasco & Lago, 1975b and Araújo & Nolasco, 1972).

It is known that plaster shows an apparent expansion from the physical and chemical point of view that leads to an increase in volume. Such setting expansion has been extensively studied. The conclusion is that the expansion is a reflex of an phenomenon of the intrinsic structure of the plaster – the crystallization and the way it progresses (Vieira & Araújo, 1987), i.e., the normal setting expansion is a consequence of the growing crystals and its progresssion.

The magnitude of this expansion can be doubled if the plaster is in contact with water during the setting reaction which characterizes the hygroscopic expansion of the material (Cardoso, 1991). It can also behave negatively when plaster is submitted to an excess of water (Lindquist, 1953).

Other products can also modify plaster. Zacaria et al (1988) has shown the effect of a dispersing liquid and a microcrystalline additive in the physical properties of commercial plaster type IV and concluded that additives modify the setting expansion and other properties of plaster.

Some authors added Arabic glue and calcium hydroxide to increase the resistance of the plaster tie and concluded that these additives had poor effect in the setting expansion (Alsadi et al. 1996). Finger (1980) showed that setting expansion to plasters type III and IV measured according to the ADA (1972) was less than that according to the authors' specific method. Sykora & Sutow (1996, 1997) compared type III and a high expansion plaster and observed that total dentures produced with high expansion plaster showed better adaptation to the posterior palatine edges than those prepared with type III plaster.

Research on desinfection of molds and plaster models demonstrated that the setting expansion of disinfected plaster ties is clinically acceptable (Drennon et al., 1989)

Ishida (1990) observed that the setting expansion of plaster may be affected according to the molding material and the mold itself. On the other hand other authors also observed that the setting expansion of plaster molds obtained with materials such as hydrophilic silicone was significantly higher than that of hydrophobic silicone (Kakuta et al., 1989).

Considering these findings, the aim of this study is to calculate the magnitude of the expansion of some types of commonly found plaster and to compare the normal data of setting expansion reported by manufacturers to requirements of ADA´s # 25 specification (1981).

MATERIALS AND METHODS

It is well known that plaster shows dimensional alteration during setting due to the interaction while crystals are growing. According to the ADA specification no. 25, such alterations, which result in expansion, may vary according to the type of plaster and are limited to the specification as shown in TABLE 1.

TABLE 1: Plaster expanation (%) according to ADA.

TYPE OF PALSTER	MÍN %	MÁX %
I	0.00	0.15
II	0.00	0.30
III	0.00	0.20
IV	0.00	0.10
V	0.10	0.30

Three types of dental plasters were used in this study – type III, IV and V with their composition in accordance to the ADA specification no. 25. Individual characteristics such as trademark, water/powder ratio and resistance to fracture and expansion are presented in TABLE 2.

TABLE 2.: Characteristic of tested plasters

Trade mark	Type of plaster	Proportion water/powder (%)	Expansion (%)	Resistance to compression (g/cm^2)
Mossoró	III	0.30-0.35	-	-
Densite	IV	0.22-0.25	0.04-0.08	350
Exadur	V	0.19-0.21	0.20	600

Distilled and dehionized water was the liquid used for mixing the plaster, measured in a measuring glass with 1 ml division. Powder was weighted in a digital scale (Sauter-K 12000). Manual spatulation was issued during 1 minute in accordance to ADA regulations (1972). The mixture was vigorously spatulated by the same operator, against the wall of the bowl and with circular movements in the same direction and intensity, being the room temperature 23 $\pm$ 2ºC and the relative humidity 50%.

SETTING TIME

Initially, the setting time of each plaster was determined with a Vicat needle which consists of a structure bearing a 2.94 N (300g) movable rod and a needle 1 $\pm$ 0.05mm in diameter and 5 cm where an adjustable pointer moves on a scale graduated in mm fixed in the structure, using plastic rings of 2 cm high and 3 cm of diameter resting on a glass baseplate. The plaster was spatulated and poured into the ring and the initial setting time was recorded at the point when it looses its brightness and, afterwards, the needle was introduced into the specimem every 15 seconds being the needle cleaned before each new penetration. The final setting time was recorded when the needle could not be fully introduced into the specimem (ADA, 1972, 1981, Ishida, 1990) (FIGURE 1)

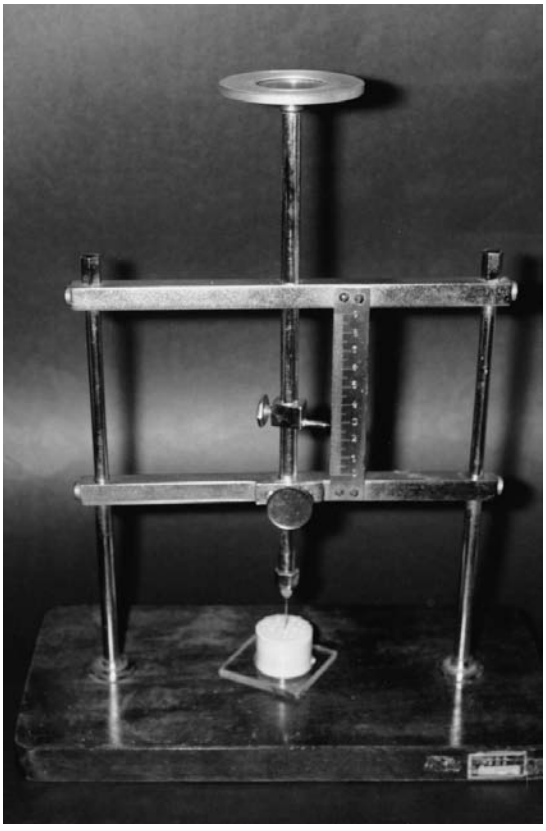

FIGURE 1 – Determination of the setting time of each plaster with Vicot needle

SETTING EXPANSION

Setting expansion was measured by a device previously described (Araújo & Nolasco, 1972, Bombonatti et al., 1978). It was used a flexible rubber ring, allowing the complete expansion of the material without having to remove the material from the glass baseplate. After adaptation of the plaster into the ring, the setting time was expected prior to the installation of the microscopic slide. This was later introduced on a metal base with a vertical support for the expansion meter clock (Mitutoyo - Absolute, in/mm). The clock was calibrated by making the brace run down till the active point could touch slightly the slide. In this moment the clock was fixed and the gouge set to zero. First measure was taken after 30 min from the beginning of saptulation and thereafter every 15 minutes until completing 2 hours (Mahler & Asgarzadeh, 1953, Nolasco & Lago, 1975a, Nolasco et al., 1975). (FIGURE 2).

FIGURE 2 – Mitutoyo clock – Absolute in/mm, device to measure the setting expansion of each material

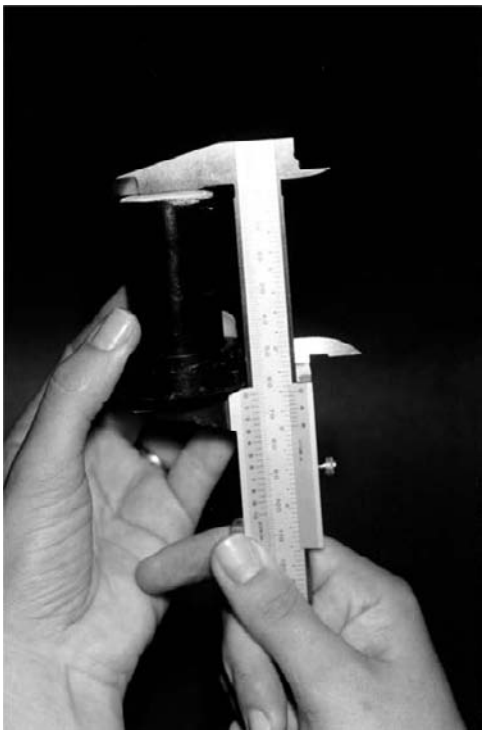

FIGURE 3 – Pachymeter measuring the final length of each cylinder

At the end, each specimem was measured with an electronic pachimeter (STARRET – graduation of 0.01mm or 0.005”), to obtain the final length of the plaster cylinder while the clock showed the expansion in mm (FIGURE 3); thus, by subtracting the expansion of the final length (L1) it was obtained the initial length (Lo) of the cylinder. With these data it was possible to calculate the percentage of the expansion, thus obtaining the normal setting expansion of each specimem according to the formula below:

$$\frac{L1 - Lo}{Lo} \times 100 = \text{expansion in \%}$$

$$L1 - \text{expanse (mm)} = Lo$$

STATISTICAL ANALYSIS

The values for “expansion” obtained in the four periods (initial length Lo, final length L1) measured 2 hours after evaluation in the three different trade marks of plaster (Mossoró, Densite and Exadur) were submitted to statistical analysis of repeated measures (average profile analysis), complemented by construction of simultaneous confidence intervals (Johnson & Wichern, 1992).

All discussion on results was based on a significance of 5%.

RESULTS AND DISCUSSION

In this study it was observed the quantity of expansion of each material in order to find the best one for dentistry purposes. The measurable expansion, in percentages, of the tested plasters was determined by a clock (Mitutoyo) special for the reading of materials in the pre-established intervals of time.

The values of expansion 2 hours after the setting time of each tested plaster was transformed in percentage and submitted to statistic analysis.

TABLE 3 - Medians of plaster expansion according to the type of material and result of Kruskal Wallis statistic test

Mossoró	Densite	Exadur	Test Result
0.33± 0.06	b 0.13±0.04 a	0.35±0.05 b	19.56 (P< 0,05)

TABLE 3 shows the results of the statistic analysis of 3 plaster types regarding the normal setting expansion. It can be seen that one of them shows difference in the average expansion regarding the others. To determine which average or averages is different , from the statistical point of view, it was used the contrast test of Turkey at a level of 5% of significance.

TABLE 3 also shows that plaster Mossoró and Exadur, i.e, type III (stone) and V (special reinforced), respectively, are similar although type V plaster shows more expansion, followed by type III and IV in decreasing order. Results are illustrated FIGURE 4.

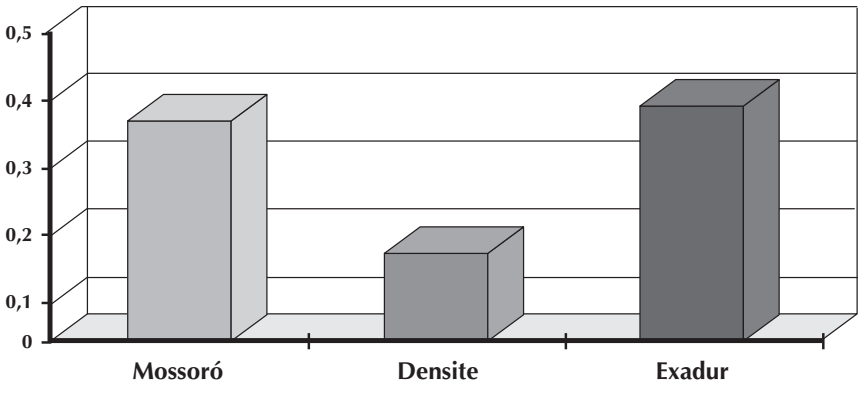

FIGURE 4 - Mean, semi-amplitude of plaster expansion according to the type of material and results of the statistical test

In a study by Daniel & Abreu (1973), with the purpose of evaluating the setting dimensional alterations of some plaster products while mounting the model in an articulator, revealed that type III (stone) plaster showed important alteration in setting, contrary to the studies of Perkins & Wheatcroft (1959) and those of the manufacturers, whereas the special plaster (IV) showed minimal modification while in use for mounting models in an articulator. This fact has also been commented by other authors (Philips, 1969).

Many factors may influence the setting expansion, among them the technique of spatulation, type of test, condition of the water (deionized or not), the composition of the plaster, among others. For this reason, Finger (1980) has proposed the measurement of the setting expansion of 2 trade marks of type IV plaster using 2 tests: one suggested by ADA(1972) and another by Jørgensen. Results showed that the setting expansion for both products measured by the ADA(1872) test was lower than those obtained by Jørgensen test.

According to Cardoso (1991), who tested plaster types II, III and IV regarding the normal setting expansion using for comparison the limit values standardized by ADA's specification no. 25(1981), type III plaster has obtained an average value higher than the recomendations, while plaster II and IV where in accordance to the standards. No author has tested type V plaster in order to classify its normal setting expansion magnitude.

Extrinsic factors could have induced such differences – that is – factors introduced during storage or manipulation. In the present study, the Mossoró plaster was stored in the Laboratory of Models in the Hospital for Rehabilitation of Craniofacial Deformities-USP and, in the moment of the test, the researcher found the plaster pack partially opened which, naturally, has favored the absorption of ambient water and consequent hydration of the plaster.

TABLE 3 - Medians of plaster expansion according to the type of material and result of Kruskal Wallis statistic test.

MOSSORÓ	DENSITE	EXADUR
0.33%	0.12%	0.34%

The average values for the tested plaster (TABLE 4) exceeded the ADA's specification no.25 (1981) in 65% for type III (Mossoró), in 20% for type IV and in 13% for type V since these suffered ambiental influences as mentioned above.

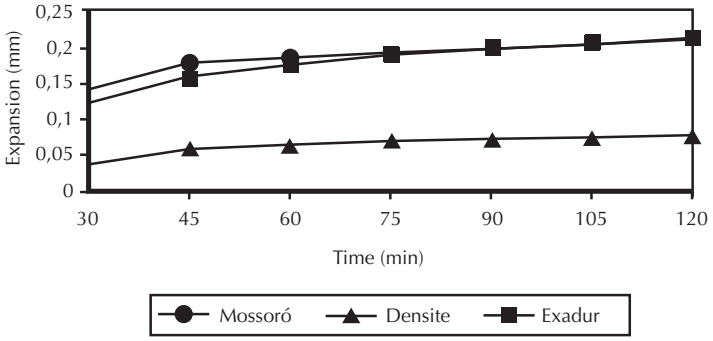

FIGURE 5 – Amount of expansion in mm of tested plaster in time intervals.

FIGURE 5 shows the magnitude of the expansion in mm of tested plaster in each pre-determined time interval. In this regard, it is observed that in the first half hour the materials have not yet attained a stable value of expansion that becomes more evident from the interval 75 minutes, with a minimal increase in expansion.

CONCLUSION

According to the methodology employed to measure the dimensional alteration of the tested plasters, and to the statistical treatment of results, the following conclusions can be drawn:

- Type IV plaster showed normal setting expansion minor than types III and V which showed statistically similar results;
- the values obtained for normal settings expansion of tested plasters type III, IV and V exceeded the ADA's # 25 (1981) specification.
- regarding the time, the authors concluded that there was a greater increase of expansion in the 30 to 45 minutes interval in all tested plasters, and that from 75 minutes there was less expansion.

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