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UTICAJ NAČINA PRIPREME NA MEHANIČKE KARAKTERISTIKE GIPSA

INFLUENCE OF PREPARATION METHOD ON MECHANICAL CHARACTERISTICS OF PLASTER

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Sažetak

Uvod: *Gips se u stomatologiji široko koristi za izradu radnih modela, kao vezivo u vatrostalnim masama i kao pomoćni materijal u laboratorijskim fazama izrade proteza. Zbog njegove krtosti, postoji stalna potreba za poboljšanjem mehaničkih svojstava. S tim u vezi, u istraživanju smo pošli od pretpostavke da se povećanjem udela praha, prilikom pripreme, gipsa poboljšavaju njegove mehaničke karakteristike.*
Cilj *ovog istraživanja je utvrđivanje značaja promene odnosa praha i tečnosti na mehaničke karakteristike gipsa (pritisnu čvrstoću).*
Materijal i metode: *U istraživanju su korišćene tri vrste gipsa: tip 2, 3 i 4. Za svaki tip gipsa pravljena su po tri uzorka sa različitim odnosom praha i količine vode (n=9). Nakon 24h, uzorci su analizirani na Mašinskom fakultetu u Nišu, na univerzalnoj mašini za testiranje.*
Rezultati: *Najmanje vrednosti pritisne čvrstoće pokazao je gips tipa 2, a veće vrednosti tip 3 i 4, bez obzira na srazmeru praha gipsa i vode. Sa porastom udela praha, povećavala se pritisna čvrstoća uzoraka.*
Zaključak: *U cilju poboljšanja pritisne čvrstoće, može se povećati udeo praha u tečnoj fazi u toku pripreme materijala bez vidljihih promena u njegovoj strukturi.*

Ključne reči: *gips, pritisna čvrstoća*

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Abstract

Introduction: *Plaster is widely used in dentistry for the production of master casts, as a binder in investment materials and as an auxiliary material in the laboratory stages of denture production. Due to its brittleness, there is a constant need to improve its mechanical properties. In this regard, in the research we started from the assumption that increasing the proportion of powder during the preparation of plaster improves its mechanical properties.*
The aim *of this research wasto determine the significance of the change in the ratio of powder and liquid to the mechanical characteristics of plaster (compressive strength).*
Material and methods: *Three types of plaster were used in the research: type 2, 3 and 4. For each type of plaster, three samples were made with different ratio of powder and amount of water (n = 9). After 24 hours, the samples were analyzed at the Faculty of Mechanical Engineering in Niš, on a universal testing machine.*
Results: *Plaster type 2 showed the lowest values of compressive strength, and higher values of types 3 and 4, regardless of the ratio of plaster powder and water. As the powder content increased, the compressive strength of the samples increased.*
Conclusion: *In order to improve the compressive strength, the proportion of powder in the liquid phase can be increased during the preparation of the material without visible changes in its structure.*

Key words: *plaster, compressive strength*

Uvod

Gips se u stomatologiji koristi za izradu radnih modela, kao vezivo u vatrostalnim masama i kao pomoćni materijal u laboratorijskim fazama izrade proteza (kalupi za polimerizaciju veštačkih smola, fiksiranje modela u artikulator). U savremenoj stomatološkoj praksi, gips se više ne koristi kao otisni materijal[1]. Pre bi se moglo reći da njegova primena, u svrhu otiskivanja bezubih ili krezubih vilica, ima istorijski značaj[2].

U svakodnevnoj prkasi, uobičajeno je da se gipsom naziva veći broj supstanci koje se razlikuju po hemijskom sastavu, što je, naravno, neprihvatljivo sa aspekta hemijskog sastava ovog materijala. Precizniji nazivi za materijale na bazi gipsa su[3]:

- gips (prirodni mineral, kao i očvrsli proizvod nastao dodavanjem vode prahu) po hemijskom sastavu je kalcijum-sulfat dihidrat;
- poluhidrat (α i β) nastaje delimičnom dehidratacijom gipsa i u hemijskom smislu predstavlja kalcijum-sulfat poluhidrat;
- dentalni gipsevi (alabaster gips, tvrdi gips, poboljšani tvrdi gips itd.) predstavljaju preparate α -poluhidrata i β-poluhidrata sa dodacima drugih supstanci;

Podela dentalnih gipseva prema ISO 6873:1998 standardu[4]:

- tip 1– Dental plaster (gips za otiske);
- tip 2– Dental plaster (gips za modele, alabaster, beli gips);
- tip 3– Dental stone (gips za modele, tvrdi gips);
- tip 4– Dental stone (gips za modele, gips velike tvrdoće i čvrstoće i male ekspanzije);
- tip 5– Dental stone (gips za modele, gips velike tvrdoće i čvrstiće i velike ekspanzije);

Dentalni gips–tip 1: Koristi se za izradu radnih modela, kao i vezivo u vatrostalnim masama i kao pomoćni materijal u laboratorijskim fazama izrade proteza.

Dentalni gips-tip 2: Koristi se za izlivanje modela za analizu i izradu individualnih kašika, kivetiranje poteza, fiksiranje modela u artikulator, izradu radnih modela u ortodonciji, izlivanje postolja radnih modela i izradu raznih držača i fiksatora.

Dentalni gips-tip 3: Njegova tipična primena je u izradi radnog modela za parcijalne i totalne akrilatne proteze, okluzalne trećine modela antagonista, radnog modela za parcijalne skeletirane proteze i radnog modela za fiksne nadoknade.

Introduction

Plaster is widely used in dentistry for the production of master casts, as a binder in investment materials and as an auxiliary material in the laboratory stages of denture production (molds for polymerization of synthetic resins, fixing the model in the articulator). In modern dental practice, plaster is no longer used as an impression material[1]. Rather it could be said that its application for the purpose of imprinting edentulousor partial edentate jaws has historical significance[2].

In everyday practice, it is common to designateas plaster a large number of substances that differ in chemical composition, which is, of course, unacceptable from the aspect of the chemical composition of this material. More precise names for plaster - based materials are[3]:

- plaster (natural mineral, as well as hardened product formed by adding water to powder) by chemical composition is calcium sulfate dehydrate
- hemihydrate (α and β) is formed by partial dehydration of plaster and in the chemical sense is calcium sulfate hemihydrate
- dental plasters (alabaster plaster, hard plaster, improved hard plaster, etc.) are preparations of α and β-hemihydrate with the addition of other substances.

Division of dental plasters according to ISO 6873: 1998 standard[4]:

- Type 1. Dental plaster
- Type 2. Dental plaster (plaster for models, alabaster, white plaster)
- Type 3. Dental stone (plaster for models, hard plaster)
- Type 4. Dental stone (plaster for models, plaster of high hardness and strength and small expansion)
- Type 5. Dental stone (plaster for models, plaster of high hardness and strength and large expansion)

Dental plaster - type 1. It is used for the production of working models, as well as a binder in investment materials and as an auxiliary material in the laboratory stages of prosthesis production.

Dental plaster - type 2. It is used for pouring models for analysis and making custom trays, denture flasking, fixing models in articulators, making working models in orthodontics, pouring stands of working models and making various holders and fixators.

Dentalni gips-tip 4: Koristi se za izlivanje najfinijih i najpreciznijih modela za izradu fiksnih nadoknada.
Dentalni gips-tip 5: Primenjuje se u fiksnoj protetici za izradu patrljaka radnih modela, gde se nadoknada lije od neplemenitih legura.
Sintetički gipsevi: Iako ovi gipsevi nisu sistematizovani po ISO standardima, njihova primena u stomatologiji je u porastu. Oni su višestruko skuplji od prirodnih gipseva, a njihove fizičke karakteristike često prevazilaze i najkvalitetnije prirodne gipseve.

Da bi se iskoristio maksimalni potencijal svake od navedenih vrsta gipsa, neophodno je odrediti pravilan odnos praha i tečnosti pri njihovoj primeni. Sa druge strane, svedoci smotoga da se u svakodnevnoj praksi pripremi gipsa pristupa rutinski, te da se materijal retko sprema prema uputstvu proizvođača. S tim u vezi, u istraživanju smo pošli od pretpostavke da se povećanjem udela praha prilikom pripreme gipsa poboljšavaju njegove mehaničke karakteristike.

Cilj ovog istraživanja je utvrđivanje značaja promene odnosa praha i tečnosti na mehaničke karakteristike gipsa (pritisnu čvrstoću gipsa).

Materijali i metode

U okviru ovog istraživanja korišćena su tri različita tipa gipsa,sa jasno definisanim fabričkim svojstvima:

- Alabaster Polident – pomoćni gips u tehnici – tip 2:

Karakteristike: Smesa kalcijumovog sulfata sa dodacima; bele boje;bez mirisa.
Odnos mešanja: voda (ml)/gips (g) – 60/100;ekspanzija: 0,16%.
Vreme stvrdnjavanja: 10 – 14 min;radno vreme: 5 – 6 min.

- *Polidur Blue Polident*– tip 3:

Karakteristike: Smesa kalcijum-sulfata sa dodacima;bez mirisa;plave boje.
Odnos mešanja: voda (ml)/gips (g) – 30/100; ekspanzija 0,18%.
Vreme stvrdnjavanja: 7 – 12 min.

- *Vet Metal Polistone Polident* – tip 4:

Karakteristike: Super tvrdi sintetički dentalni gips; smesa kalcijum-sulfata sa dodacima; bež boje, bez mirisa.
Odnos mešanja: voda (ml)/gips (g) – 22/100;ekspanzija: 0,10%.
Vreme stvrdnjavanja: 13 – 15 min.

Uzorci gipsa (Slika 1) pravljeni su u metalnom kalupu, čije su dimenzije bile 3 cm x3 cm x5cm. Dobijeni su uzorci oblika kvadra, ravnih i međusobno paralelnih površina, koji su šmirglom ispolirani.

Dental plaster - type 3. Its typical application is in the production of a working model for partial and total acrylic dentures, occlusal thirds of the antagonist model, a working model for partial skeletal dentures and a working model for fixed restorations.
Dental plaster-type 4. It is used for casting the finest and most precise models for making fixed restorations.
Dental plaster -type 5. It is used in fixed prosthetics for making stumps of working models, where the compensation is made of base alloys.

Synthetic plaster. Although these plasters are not systematized according to ISO standards, their application in dentistry is on the rise. They are more expensive than natural plasters, and their physical characteristics often exceed even the highest quality natural plasters.

In order to use the maximum potential of each of the mentioned types of plasters, it is necessary to determine the correct ratio of powder and liquid during their application. On the other hand, we are witnesses that in everyday practice the plaster preparation is approached routinely, and that the material is rarely prepared according to the manufacturer's instructions. In this regard, in the research we started from the assumption that increasing the proportion of powder during the plaster preparation improves its mechanical properties.

The aim of this research wasto determine the significance of the change in the ratio of powder and liquid to the mechanical characteristics of plaster (compressive strength of plaster).

Materials and methods

Within this research, three different types of plaster with clearly defined factory properties were used:

- Alabaster Polident - Auxiliary plaster in technique - Type 2.

Characteristics: Mixture of calcium sulfate with additives. White. Odorless.
Mixing ratio: water (ml)/plaster (g) - 60/100. Expansion: 0.16%.
Curing time: 10-14 min. Working time: 5-6 min.

- Polidur Blue Polident - Type 3

Characteristics: Mixture of calcium sulfate with additives. Odorless. Blue.
Mixing ratio: water (ml)/plaster (g) – 30/100. Expansion 0.18%.
Curing time: 7-12 min.

- Vet Metal Polistone Polident - Type 4

Za svaki tip gipsa pravljena su po tri uzorka sa različitim odnosom praha i količine vode (n=9), prikazanim u tabelama 1 do 3. Količina vode merena je špricem. Masa gipsa merena je na digitalnoj vagi. Mešanje gipsa obavlja se tako što se prah dodaje u vodu i meša ručno, pomoću gumene šolje i špatule.

Nakon 24h, uzorci su analizirani na Mašinskom fakultetu u Nišu, na univerzalnoj mašini za testiranje.

Pri ispitivanju pritiskivanjem pod dejstvom aksijalnih sila nastaje smanjenje visine uzorka, do loma (Slika 2).

Characteristics: Super hard synthetic dental plaster. A mixture of calcium sulfate with additives. Beige, odorlessMixing ratio: water (ml)/plaster (g) - 22/100. Expansion: 0.10%. Curing time: 13-15 min.

- Plaster samples (Figure 1) were made in a metal mold whose dimensions were 3x3x5cm. Samples of square shape with flat and parallel surfaces were obtained, which were polished with sandpaper.

For each type of plaster, three samples were made with different ratio of powder and amount of water (n=9), shown in Tables 1 to 3. The amount of water was measured with a syringe. The mass of plaster was measured on a digital scale. The plaster is mixed by adding the powder into the water and mixing it by hand, using a rubber cup and a spatula.

Slika 1. Uzorci gipsa
Fig. 1. Plaster samples /

Tabela 1. Odnos praha i tečnosti u uzorcima Alabaster Polident gipsa (tip 2)
Table 1. Powder/liquid ratio in Alabaster Polident plaster samples (type 2)

Uzorak/Sample	Masa gipsa/Plaster mass	Količina vode/Water amount
1	50g	30ml
2	60g	30ml
3	70g	30ml

Tabela 2. Odnos praha i tečnosti u uzorcima Polidur Blue Polident(tip 3)
Table 2. Powder/liquid ratio in Polidur Blue Polident samples (type 3)

Uzorak/Sample	Masa gipsa/Plaster mass	Količina vode/Water amount
1	90g	30ml
2	100g	30ml
3	110g	30ml

Tabela 3. Odnos praha i tečnosti u uzorcima Vet Metal Polistone Polident (tip 4)
Table 3.Powder/liquid ratio in Vet Metal Polistone Polident samples (type 4)

Uzorak/Sample	Masa gipsa/Plaster mass	Količina vode/Water amount
1	90g	25ml
2	100g	25ml
3	110g	25ml

Pritisna čvrstoća određuje se samo kod krtih materijala i predstavlja odnos maksimalne pritisne sile (F_{pm}), pri kojoj nastaje lom uzorka i prvobitne površine poprečnog preseka epruvete (A_0), što se određuje sledećom formulom:

$$\sigma_{pm} = F_{pm} / A_0$$

After 24 hours, the samples were analyzed at the Faculty of Mechanical Engineering in Niš, usinga universal testing machine.

When tested by pressing under the action of axial forces, there is a decrease in the height of the sample, up to fracture (Figure 2). The compressive strength is determined only for brittle materials and represents the ratio of the maximum compressive force (Fpm) at which the sample breaks and the original cross-sectional area of the specimen (A0), which is determined by the following formula:

$$\sigma_{pm} = F_{pm} / A_0$$

Slika 2. Testiranje uzoraka
Fig. 2. Testing samples

Rezultati

Dobijene vrednosti pritisne čvrstoće gipsa date su u tabeli 4.

Različite vrednosti pritisne čvrstoće dobijene su u zavisnosti od tipa testiranog gipsa, ali i udelnog odnosa praha i tečnosti.

Najveću pritisnu čvrstoću pokazao je žuti gips, manje vrednosti plavi, dok je lom pod pritiskom kod belog gipsa bio najlakše moguć. Sa porastom mase dodatog praha gipsa u istu količinu vode, poboljšana su mehanička svojstva uzoraka, odnosno poboljšana je pritisna čvrstoća.

Results

The obtained values of plaster compressive strength are given in Table 4.

Different values of compressive strength were obtained depending on the tested plaster type, but also the specific ratio of powder and liquid.

The highest compressive strength was shown by yellow plaster, lower values by blue, while the fracture under pressure in white plaster was the easiest possible. With the increase of the mass of added plaster powder in the same amount of water, the mechanical properties of the samples, i.e., the compressive strength, improved.

Tabela 4. Pritisna čvrstoća gipsa
Table 4.Plaster compressive strength

Broj/Uzorak Number/Sample	**Pritisna čvrstoća / Compressive strength, Rm (MPa)**		
	Alabaster Polident X±SD	Polidur Blue Polident X±SD	Vet Metal Polistone Polident X±SD
1 (n=3)	14.1±0.6	36.7±2.4	56.3±4.5
2(n=3)	18.2±2.0	41.4±3.3	62.3±4.9
3(n=3)	27.5±2.7	51.7±2.9	77.0±4.8

X-median, arithmetic mean, SD-standard deviation
X-mediana, aritmetička sredina, SD-standardna devijacija

Diskusija

Mehanička svojstva materijala čine skup svojstava koje definišu njihovo ponašanje kada su izloženi dejstvu spoljašnjih sila i određuju mogućnost ili nemogućnost njihove primene u izradi neke konstrukcije. Mehanička svojstva koja se najčešće ispituju jesu čvrstoća, elastičnost, žilavost i tvrdoća[5].

Istraživanje je imalo za cilj da utvrdi kako odnos praha gipsa i vode utiče na pritisnu čvrstoću materijala. Testiranje je izvršeno na tri različita tipa gipsa, sa jasno definisanim indikacionim područjem u stomatologiji. Sam postupak vezivanja odvija se po hemijskoj reakciji, koja je univerzalna za sve stomatološke gipseve[6].

Mešanjem praha dentalnog gipsa sa vodom, poluhidrat ponovo prelazi u dihidrat i oslobađa se toplota, nakon čega dolazi do reakcije vezivanja, koja prolazi kroz tri faze:

- faza 1 – poluhidrat i dihidrat, pomešani sa vodom, delimično se rastvaraju;
- faza 2 – kada dođe do povećanja koncentracije jona u vodi, dihidrat se kristališe, a polihidrat se i dalje rastvara,što je posledica veće rastvorljivosti poluhidrata od dihidrata;.
- faza 3 – dolazi do kristalizacije. Dihidrat se kristališe, a poluhidrat se rastvara. Rezultat je tvrda masa kalcijum-sulfata dihidrata;

Srazmerno veća količina praha dovodi do jače kristalizacije dihidrata i jačeg otvrdnjavanja gipsa. Rezultati istraživanja pokazali su to da dodavanje veće količine praha u istu količinu vode stvara uzorke otpornije na lom.

Mehanička postojanost gipsanih modela kao modela, za studije u atrikulatoru ili paralelometru i kao radnih modela za izradu svih vrsta zubnih nadoknada, od izuzetnog je značaja. Može se reći da je gips

Discussion

Mechanical properties of materials are a set of properties that define their behavior when exposed to external forces and determine the possibility or impossibility of their application in the manufacture of some structures. The mechanical properties that are most often tested are strength, elasticity, toughness, hardness[5].

The research aimed to determine how the ratio of plaster powder to water affects the compressive strength of the material. Testing was performed on three different types of plaster with a clearly defined indication area in dentistry. The bonding process itself takes place according to a chemical reaction that is universal for all dental plasters[6].

By mixing the powder of dental plaster with water, the hemihydrate turns into dihydrate again and the heat is released. This is followed by a binding reaction that goes through three phases:

- Phase 1 - hemihydrate and dihydrate, mixed with water, are partially dissolved.
- Phase 2 - when the concentration of ions in water increases, the dihydrate crystallizes and the polyhydrate continues to dissolve. This is due to the higher solubility of hemihydrate than dihydrate.
- Phase 3 - Crystallization occurs. The dihydrate crystallizes and the hemihydrate dissolves. The result is a solid mass of calcium sulfate dihydrate.

A relatively larger amount of powder leads to stronger crystallization of dihydrate and stronger hardening of plaster. The results of the research showed that adding a larger amount of powder to the same amount of water creates samples more resistant to breakage.

The mechanical stability of plaster models as a model for studies in the articulator or parallelometer and as working models for the production of all types of dental restorations is of great importance.

osnovni pomoćni stomatološki materijal, te da se, uprkos stalnom istraživanju i uvođenju novih vrsta optisnih materijala, njegova upotreba, u cilju njihove reprodukcije u pozitivu, nije promenila. Novi materijal za radne modele (ukoliko zamemarimo CAD/CAM tehnologiju) i ne postoji. Stoga je svako istraživanje u polju unapređenja kvaliteta gipsa veoma važno[7]. Gips treba da bude mehanički postojan, kako bi izdržao sve proceduralne faze izrade stomatoloških nadoknada. Ako uzmemo u obzir toda je gips krt materijal, postoji mogućnost oštećenja radnog modela u toku rada. Rezultati istraživanja pokazali su toda dodatak veće količine praha može poboljšati čvrstoću dobijenog modela, odnosno smanjiti rizik od preloma prilikom izrade stomatoloških nadoknada. Pri tome,sam izgled uzoraka nije sepromenio, što znači da se ovaj model pripreme materijala može promeniti u praksi, bez bojazni da se kompromituje sam postupak izrade stomatoloških nadoknada.

Rezultati su, takođe, pokazali i razliku u ispitivanom mehaničkom svojstvu čvrstoće u odnosu na tip testiranog dentalnog gipsa. Kao što je i očekivano, najmanju čvrstoću pokazao je alabaster, odnosno beli gips, bez obzira na srazmeru praha i vode. Veće vrednosti prikazane su kod plavog, a najveće kod gipsa za specijalne radne modele. Potvrđivanjem rezultata, koje su dobili i drugi autori u svojim istraživanjima, stomatološke gipseve možemo klinički egzaktno klasifikovati, upotrebljavajući one koji odgovaraju jasnoj indikaciji, a sa druge strane, kontrolišući njihova mehanička svojstva pravilnim odabirom odnosa praha i tečnosti.

Literaturni podaci pokazali su težnju istraživača da poboljšaju mehanička svojstva stomatoloških gipseva. Mehanička čvrstoća gipsa može se poboljšati i dodatkom silikatnih nanočestica, što potvrđuje činjenica da porastom čvrste faze dobijamo materijal bolje čvrstoće[8]. Abdullah je predložio smanjenje površinske hrapavosti gipsa, kao i povećanje kompresivne čvrstoće i dimenzionalne stabilnosti radnih modela potapanjem u hipohloričnu kiselinu[9]. Yap i sar. dokazali suda sušenje uzoraka gipsa u mikrotalasnoj peći povoljno utiče na njegove karakteristike i sprečava deformaciju[10]. Silva i sar. predložili su isušivanje gipsanih modela u mikrotalasnoj peći ili na sobnoj temperaturi, kao efikasan metod za poboljšanje kompresivne čvrstoće[11].

It can be said that plaster is the basic auxiliary dental material, and that, despite constant research and the introduction of new types of impression materials, its use in order to reproduce them in a positive has not changed. There is no new material for working models (if we ignore CAD CAM technology). Therefore, any research in the field of plaster quality improvement is very important[7]. Plaster should be mechanically durable to withstand all procedural stages of making dental restorations. If we take into account that plaster is a brittle material, there is a possibility of damaging the working model during work. The results of the research showed that the addition of a larger amount of powder can improve the strength of the obtained model, i.e.,reduce the risk of fractures when making dental restorations. At the same time, the appearance of the samples did not change, which means that this model of material preparation can be applied in practice without fear of compromising the process of making dental restorations.

The results also showed a difference in the examined mechanical property in relation to the type of tested dental plaster. As expected, alabaster, i.e., white plaster, showed the lowest strength, regardless of the ratio of powder and water. Higher values are shown for blue, and the highest for plaster for special working models. By confirming the results obtained by other authors in their research, we can classify dental plasters clinically exactly, using those that correspond to a clear indication, and on the other hand controlling their mechanical properties by correctly choosing the ratio of powder and liquid.

The literature data have shown the tendency of researchers to improve the mechanical properties of dental plasters. The mechanical strength of plaster can also be improved by the addition of silicate nanoparticles, which confirms that with the increase of the solid phase, we obtain a material of better strength[8]. Abdullah proposed a reduction in the surface roughness of plaster, as well as an increase in compressive strength and dimensional stability of working models by immersion in hypochlorous acid[9]. Yap et al. have proved that drying plaster samples in a microwave oven has a favorable effect on its characteristics and prevents deformation[10]. Silva et al. have proposed drying plaster models in a microwave oven or at room temperature as an effective method for improving compressive strength[11].

Zaključak

Gips je jedan od osnovnih pomoćnih materijala u stomatologiji, ali je zbog svoje krtosti podložan oštećenjima. U cilju poboljšanja pritisne čvrstoće, može se povećati udeo praha u tečnoj fazi u toku pripreme materijala bez vidljihih promena u njegovoj strukturi. Najmanje vrednosti pritisne čvrstoće pokazao je gips tipa 2, a veće vrednosti tip 3 i 4, bez obzira na srazmeru praha gipsa i vode.

Conclusion

Plaster is one of the basic auxiliary materials in dentistry, but it is susceptible to damage due to its brittleness. In order to improve the compressive strength, the proportion of powder in the liquid phase can be increased during the preparation of the material without visible changes in its structure. Plaster type 2 showed the lowest values of compressive strength, and higher values of type 3 and 4, regardless of the ratio of plaster powder and water.

LITERATURA /REFERENCES

1. Papadiochos I, Papadiochou S, Emmanouil I. The Historical Evolution of Dental Impression Materials. J Hist Dent 2017; 65(2):79-89.
2. Stamenković D i sar. Stomatološki materijali: Zavod za udžbenike i nastavna sredstva Beograd; 2003.
3. http://info.whipmix.com/what-gypsum-materials-should-i-use-stone-or-plaster
4. www.iso.org › standard. ISO 6873:2013 - Dentistry — Gypsum products – ISO
5. Petković D, Krunić NB, Kostić MM, Petrović DM, Radenković GM. Strenght testing of the relation between plate dentures and materials for making soft liners. Acta Stomatol Naissi. 2012; 28(66): 1171-1179.
6. Grković B, Teodosijević M. Zubnotehnički materijali: Zavod za udžbenike i nastavna sredstva Beograd 1989.
7. Murata H, Hong G, Li YA, Hamada T. Compatibility of tissue conditioners and dental stones: effect on surface roughness. J Prosthet Dent 2005; 93(3):274-81.
8. De Cesaro L, de Oliveira EMN, Junior LHB, Papaleo RM, Mota EG. The addition of silica nanoparticles on the mechanical properties of dental stone. J Prosthet Dent 2017; 118(4):535-539.
9. Abdullah MA. Surface detail, compressive strength, and dimensional accuracy of gypsum casts after repeated immersion in hypochlorite solution. J Prosthet Dent 2006; 95(6):462-468.
10. Yap AU, Yap SH, Teo JC, Tay CM, Ng KL, Thean HP. Microwave drying of high strength dental stone: effects on dimensional accuracy. Oper Dent 2003;28(2):193-199.
11. Silva MA, Vitti RP, Consani S, Sinhoreti MA, Mesquita MF, Consani RL. Linear dimensional change, compressive strength and detail reproduction in type IV dental stone dried at room temperature and in a microwave oven. J Appl Oral Sci 2012; 20(5):588-593.