

Effectiveness of Various Gingival Sulcus Widening Materials

DIANA CERGHIZAN¹, TIBERIU TIRCA^{2*}, IOANA GEORGIANA BUMBESCU¹, MIHAELA MONICA SCUTARIU³, AURELIANA CARAIANE⁴

¹University of Medicine and Pharmacy, Faculty of Dental Medicine, Fixed Prosthodontics Department, 38 Gheorghe Marinescu Str., 540139, Tirgu Mures, Romania

²University of Medicine and Pharmacy, Faculty of Dental Medicine, 2 Petru Rares Str., 200349, Craiova, Romania

³Grigore T.Popa University of Medicine and Pharmacy, 16 Universitatii Str., 700115, Iasi, Romania

⁴Ovidius University of Medicine and Pharmacy, Faculty of Dental Medicine, 7 Ilarie Voronca Str., 900179, Constanta, Romania

The gingival-dental sulcus is a V-shaped depression located around the tooth neck; the space surrounded by the free gingival edge, the tooth (near the enamel-cement junction), and the junction between the gum and the tooth (epithelial junction); it contains the gingival sulcus fluid and the dental plaque. The long-term clinical success of prosthetic restorations depends on the careful and accurate completion of several procedures. One of the difficult procedures is the management of gum tissues and gum aesthetics. Their goal is to maintain the normal appearance of the healthy gum. Achieving this goal requires optimal periodontal health before treatment and minimal injury during treatment. The best way to optimize these things is to avoid touching the gum with the restoration materials. Our research was conducted on a number of nine (9) voluntary patients. Gingival sulcus widening is important for the accuracy of the impression for a future fixed prosthetic work, especially when the finishing line is in contact with the gingival sulcus. Dilation of the gingival sulcus is also important when crown restorations are performed in the cervix area due to the contact of the bare material with the periodontal tissues. Among the methods used for dilating the gingival sulcus, non-surgical ones are preferred by practitioners. For aesthetic and functional reasons, the edges of prosthetic restorations are placed under the gum. Therefore, the practitioner should record as accurately as possible the finishing edges to allow adequate edge integrity for restoration. This can be done by dilating the gingival sulcus, but also by providing a clean and dry space. In order to create a faithful mockup of the soft and hard tissue of the oral cavity, the gum around the prepared teeth should be thoroughly checked. This gum should be displaced and bleeding is avoided.

Keywords: gingival sulcus, marginal bone resection, biological depths, minimal injuries, impression accuracy

The dental-gingival junction area between the bottom of the gingival sulcus and the alveolar bone ridge is described as biological space. It includes the junction epithelium and the super-alveolar fiber complex covering the alveolar bone ridge. In 1961, Gargiulo reported that epithelial insertion was made on an average distance of 0.97 mm (between 0.71 and 1.35 mm) and the connective attachment on an average length of 1.07 mm (1.06 - 1.08 mm). The average width of the biological space is about 2.04 mm. Biological space is a constant of all healthy periodontium teeth [1,2].

Similar measurements of the gingival sulcus were assessed by Vacek et al. in 1994. They noticed that the mean depth of the gingival sulcus was 1.91 mm (1.14 for epithelial insertion and 0.77 mm for connective attachment) [3]. The sulcular fluid is filtered in the gingival sulcus, from the chorion, the fluid having the following functions: clears the gingival sulcus of the impurities that are filtered at this level; strengthens epithelial attachment by adhesive proteins; provides local defense due to its content of immunoglobulins and specific antimicrobial antibodies [1].

The gingival sulcus area is at the forefront of periodontal targets, as the sulcus ultimately represents the synthesis of biological requirements and mechanical needs.

The placement of the prosthetic restoration edges in relation to the gingival sulcus requires the presence of a healthy marginal gum and known gingival sulcus morphology [1].

Tooth crown conditions can occur in one or more teeth. They may be associated with edentulousness and/or an

uneven occlusal plane, which require large prosthetic restorations of the dento-maxillary apparatus.

Single-tooth prostheses aggregate to a single tooth, but they may also be used as aggregators in fixed partial dentures or immobilization systems. Choosing one or the other of the fixed prosthesis therapy methods and procedures is based on knowing the benefits and the disadvantages of each of them in relation to the specificity of the clinical case [1].

These prosthetic restorations frequently have cervical margins, which are deliberately placed in the gingival sulcus for aesthetic reasons. In this case, the dentist should achieve an impression that accurately reflects the finishing line.

The main reason why this area is not faithfully recorded on the impression is the poor gingival sulcus dilation technique [4]. The procedure used to facilitate the recording of a correct finishing area is by gingival *displacement*, which is the opposite of gingival *retraction* [5].

The purpose of the procedure is to reversibly displace the gingival tissue horizontally so that the low-viscosity impression material penetrates the dilated area [4].

Prior to any prosthetic treatment, a careful diagnosis and through treatment plan are indispensable. The planning of the therapeutic stages allows the sequence of interventions to be determined according to the planning goals approved by the patient and depending on his/her motivation, priorities and expectations.

Each type of fixed prosthesis has its own indications and contraindications, it requires a particular technique of

*email: tiberiu.tirca@yahoo.com

preparation of abutments or cavities, depending on the specificity of each clinical case.

Whenever possible, the margins of the preparations should be above the gum. The subgingival margins of cemented conjunctive restorations have been identified as major etiological factors for the occurrence of periodontal disease, particularly when interfering with epithelial insertion [7].

The extension of the marginal boundary of the preparations over the biological space causes the inflammation of the periodontal tissues and consecutive anatomical changes [8].

Marginal gum injury during grinding may occur even if the preparation is done with great care. Any gingival tissue injury causes inflammation, and after the inflammatory process ends, the outline of the gingival margin will be altered [9].

Literature data has shown that placing the edges of prosthetic restorations in the gingival sulcus promotes the accumulation of dental plaque and subsequently a form of chronic gingivitis. Moreover, the deeper the sulcus is penetrated, the more severe the inflammatory reaction. The supragingival margins are best tolerated [10].

When selecting the cross-section shape of the marginal configuration of dental abutment preparations, the following general criteria should be taken into account: to be easily achieved, without unnecessary over-extensions; to be easily identifiable on the impression and then on the mockup; to make a distinctive border able to support the wax mockup; to allow a sufficient thickness of material in order to facilitate the handling of the wax mockup without deformation and at the same time to give the restoration strength and aesthetic effect (for porcelain); to preserve dental structures [7].

The term *emerging profile* refers to the outline of the tooth at the gingival margin, as it appears from the gingival sulcus [9]. It may be extended in the vestibular and oral areas to the anatomical equator of the tooth. Interproximally, it stretches from the foot of the gingival sulcus, from the enamel-cement junction, to the interdental contact area. Restorations with a straight emerging profile in the gingival third facilitate the access of hygiene tools [11].

If this profile is over-outlined, it will be more difficult to remove the plaque. A prominent edge of any restoration material is probably the most dangerous alteration of the emerging profile, because it is almost impossible to clean the area underneath it [9].

The tooth preparation technique must provide the space required for the restoration material, without over-outlining the emerging profile. This criterion is complied with by the gingival threshold with bevel. The angle of emergence with the long axis of the tooth will be $+ 15^\circ$.

Impression materials have properties such as accuracy, precision and durability. In addition to choosing the material, proper control of moisture and soft tissues is essential [12]. A fixed prosthesis requires an accurate impression that accurately renders the terminal area of the prepared tooth.

The elastic impression materials are inserted into the oral cavity in a semi-fluid state. Since they are hardly compressible, they fail to remove the free gum and interdental papilla [1].

In the unprepared gingival sulcus, the fluid impression material hardly manages to penetrate, but the edges of such an impression will be thin, brittle and deformable, resulting in an inaccurate impression. In order to faithfully

reproduce the gingival sulcus, it must be prepared for impression. Gingival sulcus widening allows the access of the impression material beyond the cervical border of the dental abutment and the achievement of an adequate thickness of the impression material [13].

Control of oral fluids, namely blood, saliva and gingival fluid, is essential during the many therapeutic phases of a fixed prosthesis restoration. For patient comfort and safety and in order to ensure optimal access and visibility for the dentist, the saliva and water introduced into the mouth during various treatments should be removed [11].

The prerequisite of temporary widening of the gingival sulcus is the integrity of the marginal periodontium. If it was injured during abutment preparation, impression should be delayed until the marginal periodontium is completely cured.

The temporary widening of the gingival sulcus is indispensable because the cervical limit of the preparations is located at the level of the gingival ridge or in the gingival-dental sulcus [1].

Gum tissue deformation during gingival sulcus dilation and impression involves four forces: retraction, recurrence, displacement and collapse [14].

For the faithful reproduction of the end of the abutment, prior gingival sulcus preparation is necessary, following precise goals. There are currently a multitude of methods for temporarily widening the gingival sulcus. A material for the widening of the gingival sulcus must meet at least three requirements: effectiveness in obtaining gingival displacement and haemostasis; Absence of irreversible damage to the gum tissues; Absence of unwanted systemic effects [11]. The gingival sulcus dilation method used by most practitioners is a combination of mechanical and chemical methods using threads containing specific haemostatic substances [4]. Each method has its own indications, some can cause injuries of varying degrees to the gingival sulcus. In practice, they may sometimes be difficult for the dentist or painful for the patient, and they usually require local anesthesia [13]. If the gum is healthy before the prosthetic restoration treatment begins, after the temporary widening of the gingival sulcus, it will regenerate, allowing the correct adjustment of the restoration to the terminal area [11]. The best of these methods is the one that does not irreversibly impair the periodontal tissues [15,16].

In the case of surgical methods, the electrotome is used to widen the gingival sulcus without reducing the height of the gingival margins, so as to allow the access of the impression material at the finishing line; it facilitates impression removal without breaking its edges. The purpose of using it is to remove several layers of cells from the inner layer of the gum; it is contraindicated in patients with pacemakers [19]. This technique is not recommended for thin, adherent gums (maxillary canine). If pigmentation is observed in the tissues, it means that the current intensity is too high, so it must be diminished [1].

Gingival rotary curettage allows both the clearing of the sulcus during conformation of the final area of the preparation with fine-grained diamond drill and the removal of the pathological tissues from the soft wall [8]. The advantages of this technique are its rapidity and fast scarification if the technique is correctly performed. Gingival curettage is not indicated for a fragile periodontium and anesthesia is mandatory [1].

Laser surgery produces non-bleeding incisions followed by rapid painless healing, with excellent results for gingival conditioning and postoperative scarring [8].

Experimental part

Material and methods

The research was conducted on 7 voluntary patients from the Faculty of Dental Medicine - University of Medicine and Pharmacy of Tirgu Mures, and 2 voluntary patients from the Faculty of Dental Medicine - University of Medicine and Pharmacy of Constanta. They were selected based on the following criteria: age between 23 and 25; to have all four second premolar in perfect condition; very good oral hygiene; healthy periodontium.

Results and discussions

In the first stage we measured the gingival sulcus with a graduated periodontal probe with rounded tip, in the oral area of the second premolars in perfect condition, in three different points: mesio-oral, oral and disto-oral. Sulcular depth ranged between 1 and 2 mm, without bleeding on probing; we recorded the initial situation in the oral cavity by an impression of the two arches by the technique of double mixture with additional silicone.

The gingival sulcus dilatation materials were inserted in a specific order. The gingival sulcus next to the tooth 1.5 was widened by a non-impregnated thread. These threads are made of cotton and are woven, which increases their absorption capacity. In the gingival sulcus of the tooth 2.5 we inserted a thread impregnated with aluminum chloride. This thread combines the quality of a woven retraction thread with the softness of a very fine metal thread.

The Access Flo paste produces gingival evacuation without harming the periodontium, by preserving the

epithelial insertion, thus achieving a better adaptation of prosthetic devices.

It is easy to remove by water and air spraying, leaving behind an *open* dry gingival sulcus. The foam was inserted at the level of the tooth 4.5.

This material is used for any situation which requires temporary marginal gingival displacement and a dry and clean sulcus. Its application has a haemostatic effect, as it contains aluminum chloride as an astringent agent.

The pressure was controlled with anatofom rolls. The dilation materials were allowed to act for 4 minutes and then removed by water and air spraying. In the next stage, the final situation was recorded by lower arch impression. All the stages were performed by the same practitioner to avoid intra-operative variability.

Negative copies were used to make positive copies. Orthodontic white plaster was used to make them. The impressions and mockups were photographed with a ruler next to them in order to have a fixed reference at the time of the measurements.

Each patient had such a record for better *data management*.

The extent of gingival retraction was assessed by analyzing photographs of the impressions and mockups using the Digimizer software. First, the 1 millimeter reference was applied on each photo using the ruler in the photograph, depending on the number of pixels.

The foam was the easiest to apply in the gingival sulcus, and the hardest to insert was the non-impregnated thread. The easier the material was handled, the more comfortable

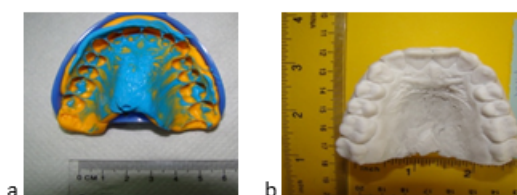
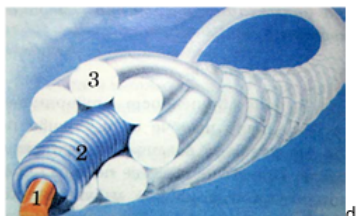


Fig.2 a,b, Photographs of the impression and mockups

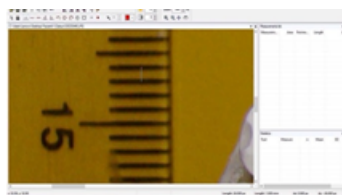


Fig.3. 1mm reference

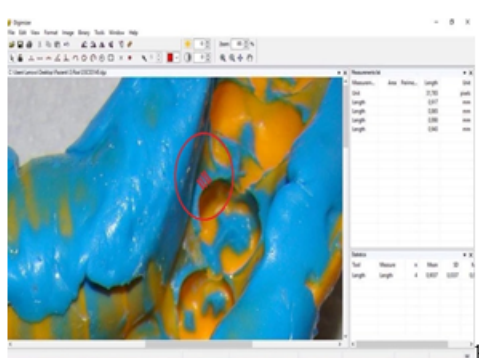
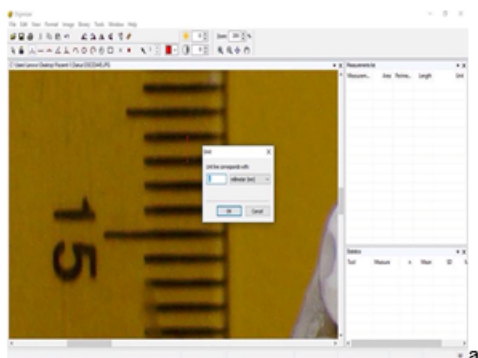


Fig.4a,b, Setting the unit of measurement; measurement of areas that interest us on the impression



Fig.5a,b, Measurement of areas that interest us on the mockup

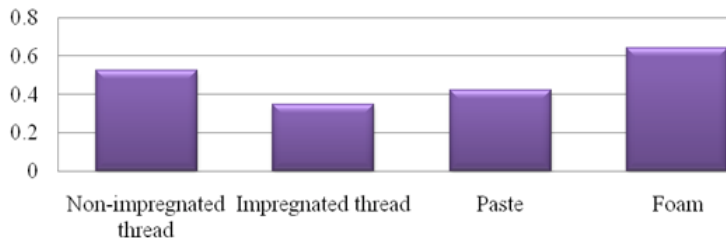


Fig.6 Horizontal dilation difference recorded on the impression, expressed in millimeters

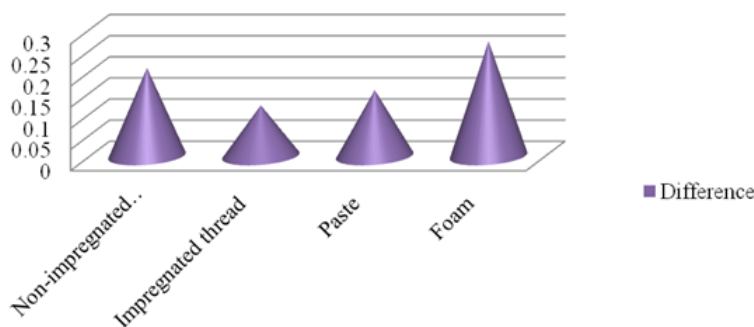


Fig.7 Horizontal dilation difference recorded on the mockups, expressed in millimeters

it was for the patient. The non-impregnated thread was reported as the most traumatic. The paste and the foam were the easiest to insert into the gingival sulcus. The longest time of insertion of the material into the gingival sulcus was recorded for the non-impregnated thread.

Bleeding was absent when removing the paste and the foam, but it was present when threads were used. Also, the results showed that a higher horizontal dilatation was recorded with the use of foam, followed by the non-impregnated thread.

The findings recorded on the mockups were proportional to those on the impressions, although their values were lower.

The gingival sulcus dilation method used by most practitioners is a combination of mechanical and chemical approaches, using threads that contain specific haemostatic agents[4].

A research conducted in 1999 by Jokstad et al. revealed that woven gingival retraction threads are considered more effective than twisted ones [1].

Many studies have investigated the effectiveness of tissue displacement, haemostasis and tissue irritation caused by various astringent agents used for gingival retraction. The vast majority of drug substances create sufficient gingival tissue displacement, so that the edges of the preparation may be exposed for impression taking [1].

The purpose of our research was to investigate gingival closure and gingival inflammation after using impregnated thread and thread-free technology.

The conclusion of our research is that, up to 60 seconds, both the techniques using threads and those not using threads were equally effective [(24,25,39)].

When the subgingival preparation is 1-2 mm deep and the marginal gum is healthy, thread-free techniques may

be the first choice, due to their advantages such as haemostasis, time saving and easy handling.

All the dilatation pastes tested caused a lower pressure than those reported for the thread-using technique, which suggests that they harm the gingival tissue less. The pressure generated for applying the paste is 10 times lower than when a thread is used [26,34,35].

The aim of the research was to measure the thickness of five gingival sulcus dilation threads from different manufacturers and to check whether there is a match between size and numbering and increasing consistency from the lowest to the highest thickness. Among the threads used in the study was the one manufactured by Ultrapack. Pieces of material were photographed and then analyzed with Adobe Photoshop CS6 and we concluded that the thickness of the threads from different manufacturers did not match a standard size. The Ultrapack thread showed an increasingly higher thickness. The dentist should be aware of the risk of using threads from different manufacturers for gingival sulcus dilation, especially when using the double thread technique [27,36].

This research was aimed at checking whether dentists could identify a clinical difference between three types of gingival retraction threads. The threads used were also different as concerns their structure, being woven or twisted, while others were impregnated with 8% epinephrine or 25% aluminum sulfate. The findings showed that woven threads were better than twisted threads, and that there was no difference between the impregnated threads. Dentists were unable to detect a clinical advantage of epinephrine-impregnated threads as compared to aluminum sulfate-impregnated threads; the research suggests that epinephrine-impregnated retraction threads may not be better than those impregnated with aluminum sulfate. Dentists should carefully analyze the limited advantages against the potential negative effects of using epinephrine containing threads [28,37].

The use of mechanico-chemical gingival retraction means depends on the patient's gum health due to the absorption of chemicals such as adrenaline. A healthy gum acts to a certain extent as a barrier to adrenaline absorption. This may be a reason why the level of overdose is theoretically not observed clinically. Absorption varies according to the degree of vascular bed exposure, thread length, chemical substrate concentration, and action time [14,38].

Studies on dogs and monkeys have concluded that gingival inflammation has occurred in most cases with subgingival restoration edges. Inflammation was due to a marginal adaptation deficit [1].

It is advisable to rinse the subgingival thread with lots of hydrogen peroxide before removing it from the sulcus, because histological studies have shown that if the thread is removed dry it tears the gingival epithelium and causes bleeding, which may cause the gum to retract [8].

The use of cotton thread soaked in astringent and haemostatic solutions provides longer gingival retraction, whereas gingival sulcuses widened using non-impregnated cotton thread close quickly [8].

According to literature data, half of the impressions taken after sulcus widening using only non-impregnated cotton threads were inaccurate and had to be repeated.

The probability of faithfully recording the terminal area decreases as the number of abutment teeth increases.

When the impression includes a limited number of abutment teeth on a semiarch and the preparations do not extend too much under the gum, a dental dam may be used, but its use should be avoided if impregnated with polyvinyl siloxane, because it inhibits the polymerization of the impression material [1].

This research aimed at a comparative study of the marginal area of fixed prosthetic device using two methods of gingival retraction (epinephrine-impregnated thread and electric scalpel) and two impression techniques (two step putty wash technique and one step putty wash technique). Cow teeth were prepared with subgingival edge. There was little difference between the electric scalpel and the impregnated thread while the two-stage impression technique was significantly better than the one-stage one [29].

Foam and paste were most easy to apply in the gingival sulcus, and for the patients it was the least traumatic, the time required to apply the 3M ESPE foam and the Access Flo paste was significantly lower compared to the time required for the retraction threads; bleeding was minimal when removing the foam and paste, as compared to the retraction threads.

Horizontal gingival sulcus dilatation was maximal when using 3M ESPE foam; foam was the most appropriate material for gingival sulcus widening in most of the variables considered.

The choice of the gingival retraction material depends on the clinical condition and the dentist's preferences; gingival retraction is an indispensable stage before impression taking for fixed prosthetic devices.

The possible problems caused by the thin edges of a fixed prosthesis can be prevented by adequate exposure of the finishing area before the impression.

The preservation of periodontal tissues at the time of restoration of the teeth is strongly influenced by the contact of the prosthesis with these tissues, which is closely connected to the quality of gingival sulcus dilation.

Since modern dentistry supports preventative and conservative treatment of oral cavity tissue, thread-free

gingival sulcus dilation techniques using paste or foam should be encouraged.

References

1. BRATU, D., NUSSBAUM, R., *Bazele clinice si tehnice ale protezarii fixe*. Timisoara: Signata, 2001. pg. 602-613.
2. MACOVEIL, PRESURA RM, ANGHEL L, STANCIU B, LOVIN N, HARET R, ARSENESCU GEORGESCU C., Coronary stent entrapment. *Postep Kardiol Inter* 2014; 10, 3 (37): 216-218.
3. PADBURY, A., EBER, R., WANG, HOM-LAY. MI, USA Interactions between the gingiva and the margin of restorations : s.n., 27 May 2002, *Journal of Clinical Periodontology*, pg. 379-383. ISSN 0303-6979.
4. DONOVAN, TERRY E., CHEE, WINSTON W.L. Current concepts in gingival displacement. 48, Los Angeles : s.n., 2004, pg. 433-444.
5. HOLMES, H M. 1968, Gingival displacement, not retraction. *Dent Survey*, p. 35.
6. FORNA, N.C., TRAISTARU, T., *Ghid de practica in protetica dentara*. 2010.
7. POPSOR, S., SUCIU, M., *Principii eseniale de protezare fixa*. Tirgu Mures : s.n., 2006. pg. 9-12.
8. FRATILA, A., BOTTOR, C., IONAS, M., 2010, Factori care influeneaza fidelitatea amprentei conventionale (chimico-manuala), *Revista Romana De Stomatologie*, Vol. LVI.
9. ISTRATE, B., MUNTEANU, C., CRIMU, C.I., IACOB, S.S., MARCELIN, B., EARAR, K., Morphological and tribological aspects of some ZrO2 coatings on Mg-Ca biodegradable alloys, *Indian Journal of Engineering and materials sciences*, 23(6), 2016: 418-424
10. MOUNT, GRAHAM J., HUME, W R. *Conservarea si restaurarea structurii dentare*. s.l. : All, 1999. pg. 226-234. ISBN: 973-684-105-7.
11. SORENSEN, J A, DOHERTY, F M., NEWMAN, M G. 1991 Gingival enhancement in fixed prosthodontics. Part I: Clinical findings.: s.n., *J Prosthet Dent*, pg. 100-107.
12. FORNA, N.C., BRATU, D., LASCU, L., *Protetica dentara*. Bucuresti : Editura Enciclopedica, 2011. pg. 608-629. Vol. I.
13. GEISSBERGER, M., PITIGOI-ARON, G., CHEU, D., *Esthetic dentistry in clinical practice*. [ed.] Marc Geissberger. 1st ed. San Francisco, CA : s.n., 2010. pg. 241-254.
14. MOLNAR, C., *Ghid practic de utilizare a materialelor dentare*. Targu Mures : University press Targu Mures, 2011. 83-89.
15. SHAH, M.J, MATHUR, S., SHAH, A., Gingival retraction methods in fixed prosthodontics: a systematic review. 1, Gujarat, India: s.n., *Journal of Dental Sciences*, Vol. III, pg. 4-9.
16. GRECU M, FLORIA M, GEORGESCU ARSENESCU C. Abnormal atrioventricular node conduction and atrioventricular nodal reentrant tachycardia in patients older versus younger than 65 years of age. *Pacing Clin Electrophysiol* 2009; 32 Suppl 1: S98-100.
17. DONOVAN, T. E., CHO, GEORGE C. 2001., Predictable aesthetics with metal-ceramic and all-ceramic crowns: the critical importance of soft-tissue management. *Periodontology* 2000, Vol. XXVII pg. 121-130.
18. ATEEQ, M., PODUVAL, S. T., KASHINATHA, H M. 3, 2011, Conventional and new techniques in gingival displacement., *Journal of Dentistry and Oral Biosciences*, Vol. II, pg. 33-37
19. KHAJURIA, R., MADAN, R., SHARMA, V., 4, December 2014; Gingival dilation- A boon in fixed prosthodontics., *Annals of Dental Speciality*, Vol. II, pg. 129-133.
20. BABA, N. Z. Gingival displacement for impression making in fixed prosthodontics. [ed.] Lily T. Garcia. 2014, pg. 45-60.
21. ISTRATE, B., MARECI, D., MUNTEANU, C., STANCIU, S., CRIMU, C.I., TRINCA, L.C., EARAR, K., In vitro electrochemical properties of biodegradable YSZ-Coated MgCa Alloy, *Environmental engineering and management journal*, 15(5), 2016.:955-963
22. EARAR, K., BICA, C., CERGHIZAN, D., ILIE, M., The Role of Functional Polymers in the Optimization of the Acrylic Biomaterials Used in Removable Prosthetic Restoration III. Behaviour of the adhesive used for the multilayer consolidation. *Mat. Plast.*, 53, no.3, 2016, p.512-517.
23. ANCUTA, C., ANCUTA, E., CHIRIAC, R., ANTOHE, M., IORDACHE, C., Anti-Tumor Necrosis Factor Alpha Therapy and Periodontal

- Inflammation in Rheumatoid Arthritis A clinical and biochemical approach, Rev.Chim.(Bucharest), **68**, no.2, 2017, p. 369
- 24.ANGHEL L, ARSENESCU GEORGESCU C. What is hiding the diabetes in the new left bundle branch block patients? Acta Endo (Buc), 2014; X (3): 425-433.
- 25.LYLAJAMS., PRASANTH, V., 2012; Gingival retraction techniques- A pre requisite in fixed prosthodontics: A review., Health Sciences.
- 26.LEVARTOVSKY, S. 2012; Tissue displacement and impression techniques..
- 27.***[Interactiv] www.centrixdental.ro.
- 28.ANTOHE,M.E., AGOP FORNA, D., ANDRONACHE, M., FEIER R., FORNA, N.C., Aspects of the therapy of partially extended edentation using modern methods - attachments as maintenance, support and stabilization, Romanian Journal of Oral Rehabilitation, Vol. 8, No. 2, April - June 2016 , pp16-25
- 29.***Dentotal. [Interactiv] 2014. www.dentotal.ro.
- 30.CHANDRA, SUMI, SINGH, AJAY, CHANDRA, CHETAN. 2, LUCKNOW, India : s.n., 2016; Effect of gingival displacement cord and cordless systems on the closure, displacement and inflammation of the gingival crevice. The Journal of Prosthetic Dentistry, Vol. 115, pg. 177-182.
- 31.BENNANI, V., INGER, M., AARTS, J.M., 2, New Zealand : s.n., August 2014, Comparison of pressure generated by cordless gingival displacement materials. The Journal of Prosthetic Dentistry, Vol. 112, p. 164.
- 32.MASSARI, CINTHYA, ANFE, TACIANA EMILIS DE ALMEIDA 'I CANEPELE, TACIANA MARCO FERRAZ. 2, Brazil : s.n., 2015, Gingival retraction: thickness measurement and comparison of different cords. Brazilian Dental Science, Vol. XVIII
- 33.JOKSTAD, ASBJORN. 3, Oslo,Norway Clinical trial of gingival retraction cords.: s.n., The Journal of Prosthetic Dentistry, Vol. LXXXI, p. 258.
- 34.WOSTMANN, BERND, REHMANN, P., TROST, D., 36, Germany : s.n., 2008; Effect of different retraction and impression techniques on the marginal fit of crowns., Journal of Dentistry.
- 35.CIOATA, R.,BALAN,A., ANTOHE,M.E.,SAVIN,C., IGNAT,G., BASNO,A., Researches Regarding New Biomaterials Involved in Sports Mouthguard, Mat. Plast. **53**, no.1, 2016, p.147-149
- 36.ACAR, OZLEM, SELIM, ERKUT. , Adana,Turkey : s.n., 2014; A clinical comparison of cordless and conventional displacement systems regarding clinical performance and impression quality. The Journal of Prosthetic Dentistry, Vol. III, p. 390.
- 37.ABADZHIEV, M., Varna,Bulgaria : s.n., 2009, Comparative research of the subgingival impression quality by fixed prosthesis using one and double cord retraction technique. Journal of IMAB, pg. 52-54.
- 38.***DentalCost. [Interactiv] 2010. www.dentalcost.es.
- 39.***Dentistry Today. [Interactiv] 2016. www.dentistrytoday.com.

Manuscript received: 12.11.2017