Effectiveness of Various Gingival Sulcus Widening Materials

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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 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

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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 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 anaesthesia 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 Tîrgu Mureș, and 2 voluntary patients from the Faculty of Dental Medicine - University of Medicine and Pharmacy of Constanța. 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 anatoform 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...
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 semicircle 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 polivinyl 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 dilatation.

Since modern dentistry supports preventative and conservative treatment of oral cavity tissue, thread-free gingival sulcus dilatation techniques using paste or foam should be encouraged.

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