

THE USE OF A SILICONE INDEX AS GUIDANCE DURING TOOTH PREPARATION

УПОТРЕБА НА СИЛИКОНСКИ КЛУЧ КАКО ВОДАЧ ПРИ ПРЕПАРАЦИЈА НА ЗАБИТЕ

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Abstract

Objective: the aim of this study is to present a case report that will demonstrate the effect that the silicone index has on the clinician's ability to appropriately perform the preparation procedure and achieve the desired geometrical shape of the prepared tooth. **Case report:** a 43 year old patient came to us with a chief complaint to find a solution for the anterior upper teeth and the two missing premolars in the lateral right side of the upper jaw. These fixed prosthetic constructions were made of zirconia with CAD/CAM technology. Before tooth preparation, we made two silicone indexes, which we used as guidance for periodical checkups of the tooth preparation procedure, in order to maintain certain characteristics (such as precise amount of reduction of the tooth surfaces and their final shape). The preparation phase was followed with a standard protocol of taking impressions, laboratory procedures and at the end, cementation of the final restorations. **Results:** with the help of the silicone indexes we managed to perform a precise preparation of the teeth, which resulted in the desired smooth and mildly tapered tooth form with satisfactory primary retentive characteristics. Also, we provided enough space for the thickness of the porcelain, in order to exploit all the benefits that this material has to offer (while in the same time not jeopardizing the integrity of the hard dental tissues and the pulp). **Conclusion:** according to our previous experience, it is important that the clinician includes a guidance system for assistance during tooth preparation (in our case, a silicone index), which not only simplifies this procedure, but can also help avoid any unwanted consequences (which are likely to occur when a free hand approach for tooth preparation is used). **Key words:** prosthodontics; dental prosthesis, denture, partial, fixed; silicone index, CAD/CAM technology

Апстракт

Цел на трудот: Целта на овој труд е да се прикаже случај, преку кој би можело да се увиди ефектот на силиконскиот клуч врз текот на препарацијата и можноста за добивање на геометриски посакуван облик на забно трупче. **Приказ на случајот:** пациент на возраст од 43 години дојде на преглед, барајќи решение за горните предни заби и двата екстрахирани преткатници на десната бочна страна од максилата. Протетските реставрации ги изработивме од цирконија со помош на CAD/CAM технологијата. Пред почетокот на препарацијата, изработивме два силиконски клучеви, кои го користевме како показател при препарацијата и со кој правевме периодични контроли, со цел за да се запазат одредени карактеристики, како степенот на редуција на забните површини и нивниот конечен облик. После извршената препарација следуваше стандардниот протокол на земање отпечатоци, лабораториска фаза на работа и на крај цементирање на финалните изработки. **Резултати:** со употребата на силиконските клучеви, успеавме да извршиме коректна препарација на забите, која резултираше со добивање на забни трупчиња со саканата благо-конусна форма и задоволителна примарна ретенција. Исто така обезбедивме доволно простор за керамиката да биде со потребната димензија, за да може да се искористат сите предности на овој материјал (без притоа да го загориме интегритетот на тврдите забни ткива и пулпиното ткиво). **Заклучок:** Според нашето досегашно искуство, секогаш пожелно е да се употребува некој метод (во нашиот случај силиконски индекс), кој би послужил како навигатор при препарацијата и би ја поедноставил истата, воедно намалувајќи ги можностите за појава на несакани последици (кои можности се големи, особено кога препарацијата се врши со слободна рака). **Клучни зборови:** протетика; забна протеза, забна протеза, парцијална, фиксна; силиконски клуч, CAD/CAM технологија.

Introduction

Teeth do not possess the regenerative ability found in most other tissues in the human body. Therefore, once enamel or dentin is lost as a result of caries, trauma or wear, restorative materials and procedures must be used to reestablish the normal form and function of the affected teeth. When the defects in the tooth structure surpass any possibility of a conservative treatment,

adequate measures should be taken for a fixed prosthodontics approach (dental crowns or bridges). Teeth require a preparation procedure in order to receive these prosthodontics restorations, and these preparations must be based on fundamental principles from which basic criteria can be developed to help predict the success of the prosthodontics treatment. These principles of tooth preparation can be divided into three categories:

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1. Biologic principles, which affect the health of the oral tissues.
 2. Mechanical principles, which affect the integrity and durability of the restoration.
 3. Esthetic principles, which affect the appearance of the patient.

All principles should be taken in consideration because they have a great impact on the success of the tooth preparation and subsequent restoration. Often, improvement in one area will adversely affect another, and striving for perfection in one may unintentionally lead to failure in another aspect. For example, in the fabrication of a metal-ceramic or all ceramic crowns, sufficient thickness of porcelain is necessary for a lifelike appearance. However, if too much tooth structure is removed to accommodate a greater thickness of porcelain for esthetic reasons, the pulpal tissue may be damaged (biologic principles) and the tooth unduly weakened (mechanical principles). Predictable accomplishment of optimum tooth preparation often entails finding the best combination of compromises among prevalent biologic, mechanical and esthetic principles.

In contemporary dental practice, ceramic materials are usually used in the fabrication of fixed prosthodontics constructions (whether it is porcelain fused to metal-PFM or all ceramic materials). In order to satisfy the mechanical and esthetic needs of the prosthetic construction, a certain amount of tooth structure must be reduced. The PFM or metal-ceramic crowns require the metal to be with a minimum thickness of 0.5 mm¹, 0.4 mm² or 0.7 mm³; the porcelain with a minimum thickness of 1.2 mm- labial and 1.5 mm- occlusal/incisal¹, 1mm- labial and 1.5 mm-occlusal/incisal³.

During tooth preparation procedures, it is of a great importance to take in consideration the minimum value needs of the restorations and the amount of tooth reduction. Clinicians often make mistakes in respect of over-preparation or under-preparation of the teeth, which can jeopardize the health of the oral tissues. When tooth preparation is excessive, there is a greater risk of damaging the pulp tissue (thus extending the time period for the fabrication of the final restoration) and decreasing the retentive characteristics of the prepared tooth (compromising the mechanical principles and the integrity of the final restoration). When tooth preparation is insufficient, it is difficult to achieve the appropriate size of the restoration; or if in this case of under-preparation, the restoration is fabricated in full size, it can have serious consequences on the adjacent tissues (hemodynamic disorders of the adjacent soft tissues, difficulty in maintaining hygiene in the interdental spaces, esthetic failure, etc.).

A large number of *In vitro* studies that evaluate preparations completed by dentists have reported these types of mistakes that occur during tooth preparation⁴. In most of these studies, clinicians demonstrated a tendency to underprepare teeth, especially when a freehand approach was used (this tendency occurred in spite of better access and visibility provided by an *In vitro* experimental setup, outside the patients mouth, on a working cast). Regardless of their years of experience, the clinicians can avoid these mistakes by including guided preparation helpers in their everyday teeth preparation. This includes the use of special silicone indexes or depth gauge burs for improving the accuracy of the preparation features.

The aim of this study is to present a case report that will demonstrate the effect that the silicone index has on the clinician's ability to appropriately perform the preparation procedure and achieve the desired geometrical shape of the prepared tooth.

Case report

A 43 year old male patient came to the Department of Prosthodontics in the University Dental Clinic Centre "St. Panteleimon"- Skopje, with a chief complaint about esthetic issues concerning the anterior upper teeth and an edentulous space with two missing premolar teeth. First, we commenced a thorough assessment of the patient's medical history, thus concluding that he is a healthy individual with no health disorders. Then, we continued with an examination of the oral health, making a comprehensive evaluation of the hard and soft oral tissues. In the lower dental arch we noticed presence of dental crowding, no signs of dental calculus or gingival inflammation and a small number of composite fillings. The upper dental arch was characterized by the presence of gaps (diastema) between 11 and 12, 11 and 21, 21 and 22, some old composite fillings and no clinical signs of tooth decay or gingival inflammation. After finishing the clinical examination, we focused our attention on finding a solution about the chief complaint by the patient seeking our help: to fulfill the edentulous space between 13 and 16, to fix the broken down composite restoration on 21, the discoloration on 22 and to correct the anterior diastema (which the patient considered to be an appearance problem) (Figure 1-a, b).

Before we engaged in any kind of treatment, radiographs (one panoramic and periapical xrays) were made in order to evaluate the condition of the alveolar bone, the periodontal tissue, presence of hidden carious lesions, residual tooth roots, etc. The radiographs displayed the following results: a correct root canal treatment was evident on 22, with no signs of periapical



Figure 1. a), b) Preview of the patient's main esthetic problem and the reason he requested our help: edentulous space between 13 and 16, broken down restoration on 21, discoloration on 22 and presence of anterior diastema.

pathology (the patient confirmed that the treatment was done 7 or 8 years ago, and the tooth has been asymptomatic since then); the edentulous area was missing teeth 14 and 15 (these teeth were present as residual roots for a couple of years and extracted an year ago by an oral surgeon) and in a good condition concerning the alveolar bone and a relatively high position of the alveolar recesses of the maxillary sinus; a Class V carious lesion according to Black's principles was found on the mesial surface on tooth 16. The radiographic evaluation was followed by an examination of the patient's occlusion, palpation of the muscles of mastication, the position of the lips and the smile line. An impression of the upper and lower dental arch was taken with an irreversible hydrocolloid (alginate) in order to fabricate diagnostic casts. The casts were mounted on a semi adjustable articulator, with a previous use of a face bow and registration of the centric relation with an Addition-cure silicone (Obite, DMG). After analyzing the relations between the dental arches inside the patient's mouth and on the articulator, we noticed that the vertical dimension was preserved with no signs of interference during anterior and canine guidance (assessment of the propulsive and lateral movements of the mandible).

The first treatment plan that we suggested to the patient consisted of placing two implants in the edentulous area (for the missing first and second premolar), a single-unit crown for 22 and a composite restoration for 21. Due to financial reasons, the patient rejected the implants and also refused a composite filling for 21 due to bad previous experience with it (the old composite restorations on this tooth kept on breaking in the past). After the patient signed a consent in which he agreed that all types of treatment plans were explained to him, we came to a mutual reasonable solution for his problem, which included: fabrication of single-unit crowns

on teeth 11, 12, 21, 22 and a 4-unit dental bridge with teeth 13 and 16 as abutments. These fixed-prosthetic constructions were made out of zirconia with CAD/CAM technology.

The first phase of the treatment began with a silicone index, which we used as guidance during teeth preparation. As a material for the fabrication of the index we used heavy bodied silicone, which consisted of two components: base and catalyst. The material was mixed so that on one spoon of base material, 6-8 graduations of catalyst were added and then the mixture was prepared by crumpling it with our fingers. When the mixture gained a dough consistency, it was positioned and adapted so that it covered not only the teeth that were going to be prepared, but also one or two adjacent teeth that would provide support and stability of the index (the index covered the following tooth surfaces: labial, occlusal/incisal and palatal) (Figure 2a). We made one silicone index for 16 (which also included 17 for support of the index) and another larger index for 13, 12, 11, 21, 22, which we gradually reduced as the preparation of the teeth proceeded from 13 to 22. After removing the index, from an occlusal/incisal point of view, it was cut longitudinal in labial-oral direction, with the cut being made from the middle of each tooth (Figure 2b). This kind of index provides a clear visualization of the shape and size of reduction of the labial, occlusal/incisal and palatal tooth surface.

After silicone indexes were made, we began with tooth preparation. The preparation was performed with a previous administration of a 2% local anesthetic-Lidocaine with adrenalin, in the form of local plexus anesthesia. We performed the preparation of teeth with great care in order to produce and maintain a deep chamfer finish line with a 1 mm width (the chamfer finish line was produced with a round-tipped tapered dia-

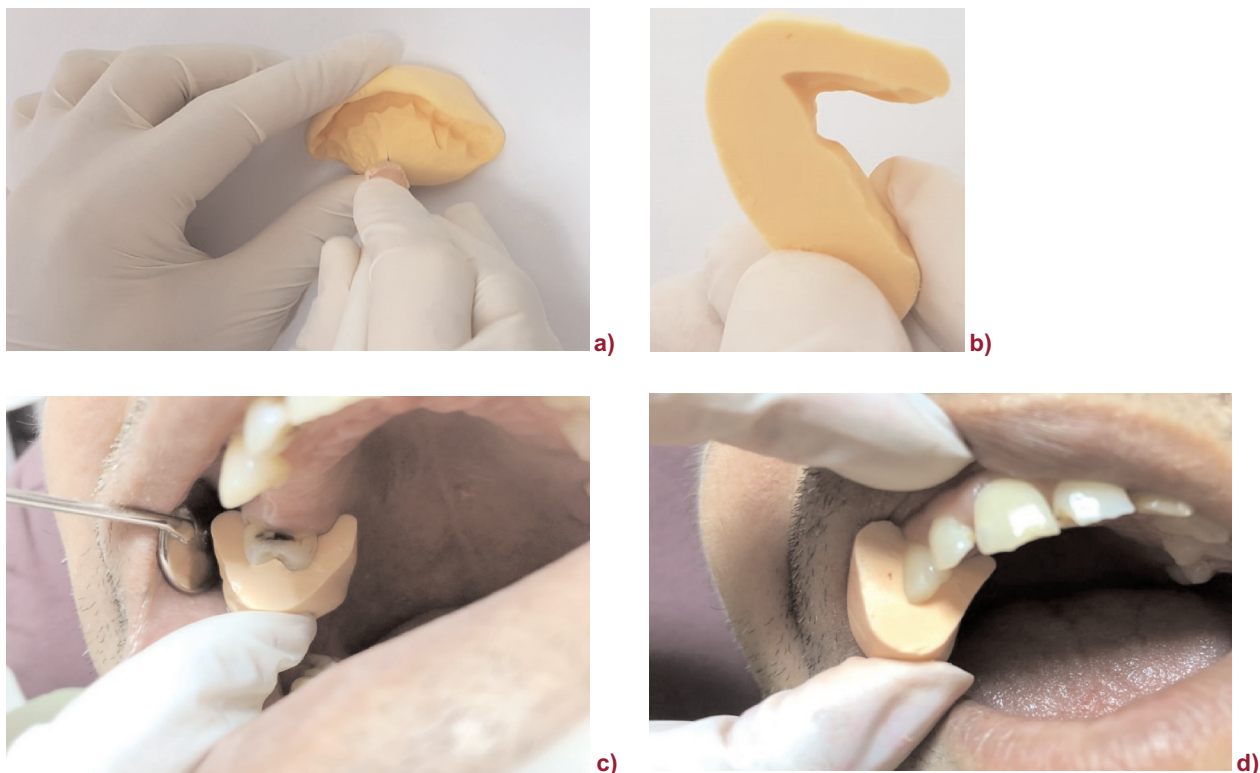


Figure 2. Fabrication of the silicone index, which was used as guidance during the preparation: a) Cutting the silicone index in a labial-oral direction; b) Visualization of the labial, palatal surface and incisal margin; c) The index adapted on the upper right first molar; d) The index adapted on the upper right canine.

mond bur5). At first, we reduced and shaped the occlusal surfaces and incisal margins with a round diamond bur, decreasing their size by 1.5-2 mm. This amount of tooth reduction doesn't only satisfy the esthetic needs, but also provides appropriate strength and enough free space for modeling the porcelain (this space is important to allow correct execution of mandibular movements). As the preparation was ongoing, we conducted periodical checkups in order to maintain the right form and size of the prepared tooth (Figure 3-a, b).

After preparing the occlusal surfaces and incisal margins, we continued with preparation of the labial surfaces by using a round-tipped tapered diamond bur. The labial surfaces were prepared in two levels: the cervical third was prepared to be parallel with the path of withdrawal, whereas the cervical and incisal thirds were mildly curved to imitate the natural tooth contour (of course this is controlled with the silicone index, making sure that the reduction on this surface is 1mm for adequate porcelain thickness). The oral surfaces were also prepared in two levels: the cervical third was reduced

with a round-tipped tapered bur in a plane parallel to the labial cervical third (parallel to the direction of withdrawal); from the cingulum to the incisal margin, the preparation consisted of producing a slight concavity with the help of a football-shaped diamond bur. The amount of tooth reduction of the lingual surface was 1 mm. The tooth preparation continued from the center of the cingulum wall into the proximal surfaces with the use of a round-tipped tapered bur, thus connecting the lingual chamfer with the labial chamfer. While preparing the proximal surfaces, the margin should follow the morphology of the free gingival crest, in order to prevent any harm to the periodontal tissues. After preparing and shaping the axial surfaces of the teeth, we proceeded in positioning the finish line subgingival in the anterior teeth and paragingival in the posterior teeth (in this case the first molar). For correctly positioning the finish line under the gingival margin and protection of the gingival tissue, we displaced the tissue by placing cords (Figure 4).

The completed chamfer finish line was 1 mm wide, smooth, continuous and free of any irregularities (presence of residual unsupported enamel)



Figure 3. a), b). As the preparation was ongoing, we conducted periodical checkups in order to maintain the right form and size of the prepared tooth. Control of the shape and size of the reduction of the canine and the upper first molar.



Figure 4. For correctly positioning the finish line under the gingival margin and in order to protect the gingival tissue, we displaced the tissue by placing cords.

At the end of the preparation, an additional check-up was made with the silicone index. After that, we continued with taking impressions with a standard metal tray in two steps: the preliminary impression was taken with a silicone material with a high bodied consistency; the second (correction) impression was taken with a silicone with a light bodied consistency. This phase ended by registering the centric relation with a face-bow, after which the work was handed off to the dental technician. The single-unit crowns and the 4-unit dental bridge were fabricated out of zirconia

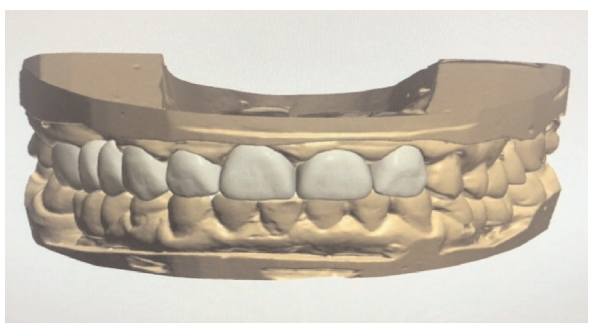
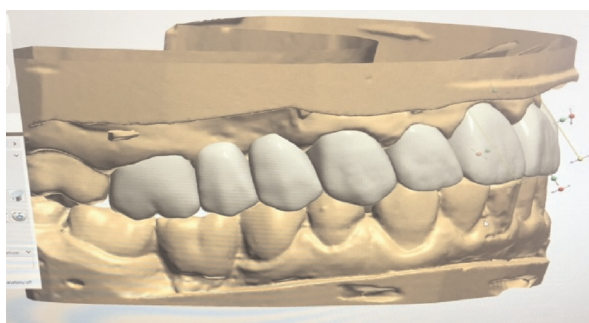
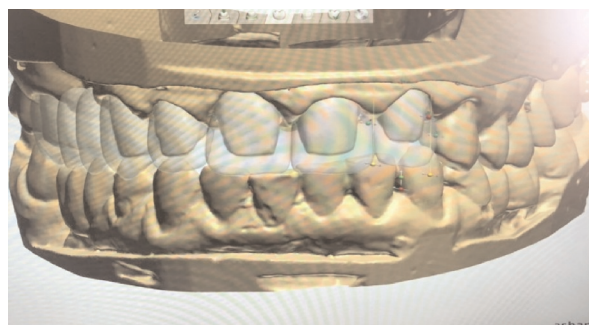


Figure 5. a), b), c), d) The single-unit crowns and the 4-unit dental bridge were fabricated out of zirconia with the use of CAD/CAM technology.



a)



b)

Figure 6. a), b) Preview of the prosthetic restorations after cementation.

with the use of CAD/CAM technology (Figure 5-a, b, c, d).

After their fabrication, we tried the restorations in the mouth of the patient, mainly because they were developed with the use of a semi adjustable articulator. The crowns and bridges were returned to the dental laboratory, where the dental technician performed the final glazing and finishing procedures. In the end, the finished restorations were cemented with the use of a glass ionomer cement (Figure 6-a, b).

Discussion

As mentioned before, the use of metal-ceramic or all ceramic materials has proven to be most effective in the fabrication of fixed prosthetic constructions in everyday dental practice. These materials have been submitted to many scientific and clinical examinations throughout the years, and still undergo changes in aspect of improving their quality and expanding their uses. The fact that these materials have well known characteristics and demands, simplifies their use in planning and producing fixed prosthetic constructions. As a result of this, the clinician knows exactly what must be undertaken in order to satisfy the mechanical considerations of these materials, namely how to perform the preparation of the teeth as to make use of these materials with all their benefits (strength, esthetic advantages, durability of the metal-ceramic or all ceramic materials)⁶. For the clinician to perform a preparation that is precise and correct, he/she must always utilize techniques for guided preparation (so called “navigators”), such as silicone indexes or depth burs.

According to Ahmed, Tracy & Petar March⁷, the use of a silicone index as guidance during tooth preparation has proven to be of great help, especially because with it, we can observe several significant technical characteristics:

- Margin (dimension/height/consistency/smoothness)
- Taper (appropriate for restorations 4-10o)

- Amount of tooth reduction (control over the thickness of the porcelain and metal)
- Comparison of teeth shape before and after preparation (important for maintaining primary retention of the construction)

Aminian & Brunton⁸ conducted a study in order to determine the effect that three different tooth preparation techniques had on the operator’s ability to appropriately and consistently prepare teeth for metal-ceramic crowns. Thirty typodont maxillary central incisor teeth were mounted individually and randomly allocated to 3 equal groups (A, B and C). One operator was asked to prepare each tooth for a metal-ceramic crown. A freehand approach was used to prepare the teeth in group A, whereas groups B and C were prepared with the assistance of a silicone index and a suitable depth gauge bur, respectively. The results of this study displayed an under-preparation of the labial surfaces and over-preparation of the incisal/occlusal surfaces when a freehand approach was used. Over-reduction of the palatal surfaces occurred when the teeth were prepared with depth gauge burs.

The labial aspect of the preparation, particularly in the cervical region, requires careful consideration during tooth preparation to prevent under-preparation. This will affect the emergence profile of the restoration and cause technical difficulties when the restoration is produced, possibly with insufficient porcelain or metal or an over bulbous crown. Parkinson⁹ in his study concluded that the creation of artificial crown contours greater than natural tooth convexities must be considered a parameter promoting endemic plaque niches. Under-reduction of finish lines may also predispose the restoration to technical failure arising from metal flexure and subsequent porcelain fracture or cement loss.

Hardik, Rupal & Hemal¹⁰ executed an In vitro study in order to determine the significance of the use of silicone indexes and depth gauge burs in tooth preparation. Ninety maxillary left central incisor teeth were allocated to three equal groups (A, B and C) of thirty and mounted on a standard working model. A freehand approach

was used to prepare the teeth in group A, whereas groups B and C were prepared with the assistance of a silicone index and suitable depth gauge burs, respectively. After the preparation, the index made prior to the preparation was injected with a light body silicone material and placed on the prepared tooth. This produced a silicone profile that displayed the amount of reduced tooth substance (the silicone profile occupied the space that was created by the tooth preparation). The index was sectioned axially along the midline of the prepared tooth with a scalpel and mounted on a microscope slide. Images of the sectioned index were captured with an optical microscope, transferred to a personal computer and calibrated image analysis software was used to measure the depth of preparation (in millimeters) at five points. The results of this study displayed under-preparation of the labial surfaces and incisal edges of the teeth whenever a freehand approach was used. In the cases when a depth gauge bur was used, an over reduction of the palatal surfaces was observed (this result was also present in the previously mentioned study by Aminian & Brunton⁷). On the other hand, in the group where a silicone index was used as guidance for the preparation, a precise and accurate reduction of the tooth surfaces of the maxillary central incisors was present.

Muller De Van stated that *the perpetual preservation of what remains is more important than the meticulous replacement of what is lost*¹¹. It is particularly important to prevent unnecessary over-reduction of tooth substance during preparation. Chandler¹² reported that a 1.5 mm reduction left more than a quarter of teeth with less than 0.5 mm peripulpal dentin, thus leaving only a little room for operator error during tooth preparation. Excessive reduction led to pulpal exposure and subsequent loss of vitality, which can lead to early failure of the restored unit.

According to Bajevska⁵, using a guidance system during preparation is of great essence in order to maintain an equal thickness of the metal and porcelain layers for an adequate distribution of the masticatory stress. In areas where porcelain is thinner, gaps or leakage may develop, that compromise the unity of the restoration. If the preparation does not provide enough space for the metal substructure, that could lead to cracking of the overlying porcelain layer, due to different elasticity deformations, which occur between the metal and the porcelain.

According to Mircev², the use of a silicone index or depth gauge bur provides a more precise preparation of the labial surfaces of the teeth, especially in the aspect of obtaining a labial surface that has two planes (the incisal third of the labial surface is under a certain angle to the other two thirds of the tooth). This provides an adequate tooth reduction and an appropriate thickness of the pro-

tective dentin layer which surrounds the pulpal tissue, thus avoiding a too bulky or oversized restoration and/or translucency of the metal substructure (Marx¹³ recommends a minimum thickness of 1 mm of the dentin that surrounds the pulp in adult patients, whereas in younger patients this thickness should be above 1.4 mm).

Conclusion

Certain undesirable phenomena that may appear in the final fixed prosthetic restoration can be caused by mistakes made in the early stages of tooth preparation (e.g. compromised esthetics, poor emergence profile, distortion of the metal substructure, insufficient primary retention and unnecessary exposure of the pulp tissue). In order to prevent any kind of mistakes from happening and to simplify the process of tooth preparation, it is important that the clinician includes a guidance system for assistance during tooth preparation (a silicone index if possible, which is more accurate according to the previously displayed results from various authors).

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