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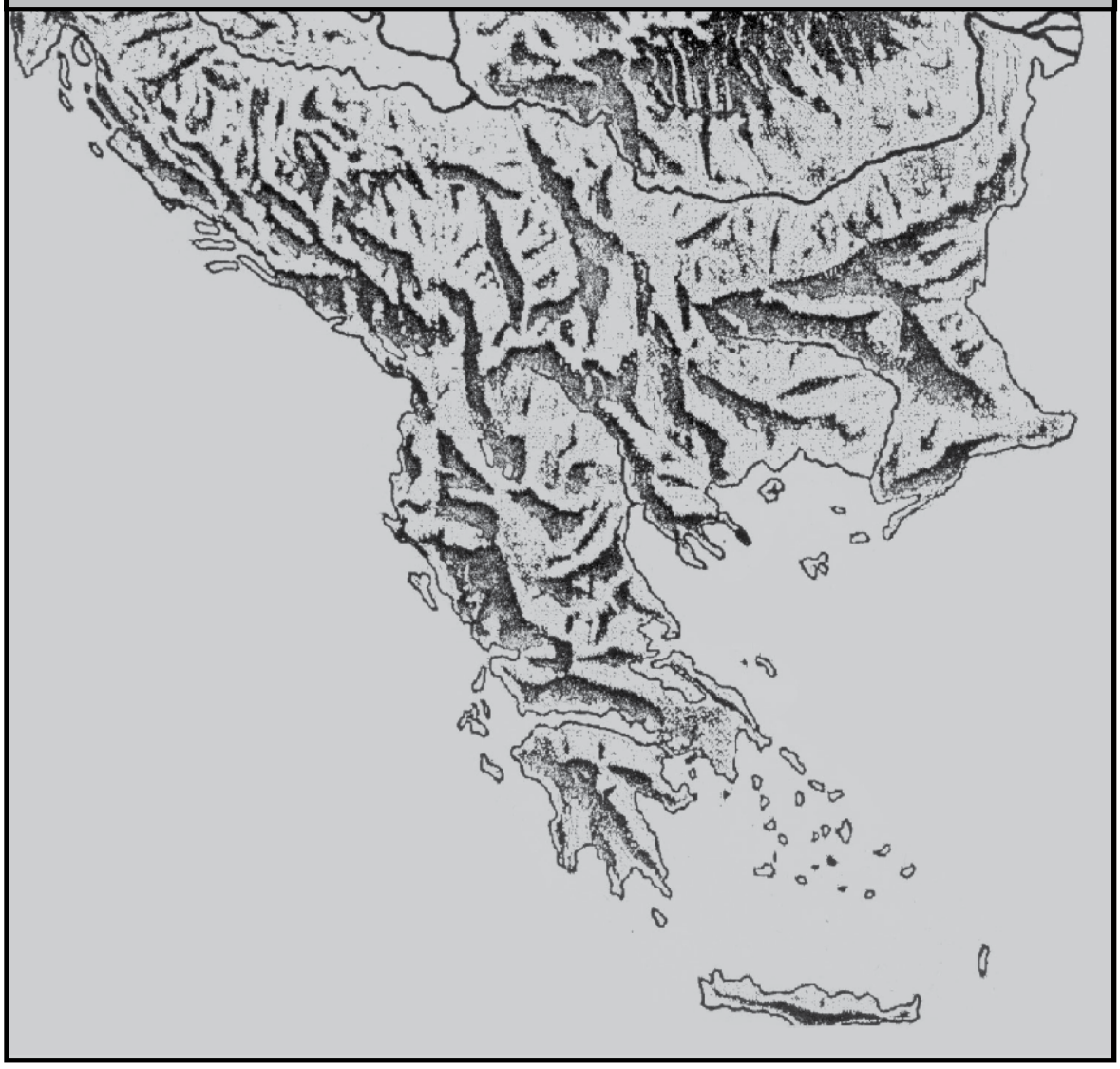

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Welcome Message

Sentence "Clever is writing, full (less clever) remembers" could be adopted in the process of writing someone's observations and scientific evidences. The finding that is not written is exclusively in the possession of individuals. Findings have no real value without sharing. Only by writing and publishing they become property of the numerous readers which gives them the true sense.

Having in mind above mention fact with logic consideration that writing have to be obligation of many people, especially of those in the field of science and profession, logical conclusion is that such writing has to have some official form. Professional and scientific papers are ideal form for presentation of practical and scientific achievements and conclusions. Journal such as BJDM is an ideal publication for all dentists from Balkan countries.

The opportunity to follow contemporary achievements from all fields of dentistry published in this journal, dentists will be in possession of the new clinical and scientific findings that could be applied to the best patient treatment achieving evidence based professional excellency in the oral health improvement. Circle of people who benefit of publishing is continuously expanding and science and practice achieve its main goal which is mankind prosperity and wellbeing.

Therefore, I wish to pay my gratitude to all those who achieved above mentioned goals by readiness to publish their knowledge in this Journal showing courage to share experiences and to educate as well.

By this the Journal continues to live and to accomplish its noble goals.

At the end, I would like to emphasis the fact that at the 21st BaSS Congress in 2016. in Banja Luka, over 450 papers were presented from all fields of dentistry and some of them, by the country of Authors, were published in the present issue of the Journal.

President of the Scientific Committee of
21st BaSS Congress, Banja Luka 2016.

Professor Sedin Kobaslija

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Factors that Determine Child Behavior during Dental Treatment

SUMMARY

In this review paper we wanted to summarize all the aspects which could affect the behavior of the child patients in the dental office. At the beginning, the factors that are related to the child patients are mentioned. Various segments of child psychological, cognitive, physiological and other kinds of development are discussed. Also, the reasons for dental fear and anxiety (DFA) and dental behavior problems (DBP) were analyzed, and how the child dental patients could cope with them. Finally, types of patients according to their behavior in the dental office were discussed. Furthermore, the influences of child patients' parents were studied, including parenting styles, as well as factors related to dentist, dental team and the dental office. Finally, critical evaluation of administration of assets to measure the presence of DFA and DBP is provided. Every part of the text was corroborated by the results from our own and other authors' recent bibliography data.

Keywords: dental fear and anxiety, dental behavior problems, children, parents, dentists

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LITERATURE REVIEW (LR)

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Background

Dental treatment, altogether with its characteristics, represents quite stressful act that have influence on all of its participants (children, their parents and dental health care personnel). Negative effects that could arise from it have short- and long-term consequences. Short-ones are related with immediate failures of dental treatment (its start, progress, end and prognosis), which can be corrected with additional efforts of attendees. Existence of long-term consequences in child patients is of special clinical importance. It is related with dental visiting avoiding, consecutive worse oral and total health of the patients during longer periods of time. The roots of these consequences have connection with psychological state of participants toward dental treatment. Realizing and understanding this psychological dimension is in modern (pediatric) dentistry, becoming unavoidable fact to pay attention to qualitative and complete dental treatment. Clinical appearances of this psychological entities are dental fear and anxiety (DFA) and dental behavior problems (DBP).

Factors Related to Child Patients

It is important to discuss the normal behavior and development of fears (including DFA) in child patients considering their age, learned behavior patterns and coping with stresses due to better understanding of patients' behavior during dental treatment.

Table 1 shows sequence of appearance of different fears in children from newborn/infant to adolescent period[1,2]. It is shown that these fears, appearing in every period until start of puberty, can be directly or indirectly related to the contents of dental office (the environment, personnel, sounds, noises and smells, instruments, pain, etc.). These are exact reasons why the DFA has the most common onset in child age, developed in one of the *Rachman* mechanisms. *Liddel* and *Gosse*[3] conducted a research concerning existence of unpleasant dental experiences in patients and they determined that those kinds of experiences happened in 90% of cases before 15th year of life of patients who reported experiencing of unpleasant dental situations. Similar findings reported some other studies like *Ost*[4], *Milgrom* and associates[5],

Locker and associates[5], as well as our research from 2010[6]. In our recent study, the results showed the differences in child patient dental behavior regarding the stressor strength, while the patients who showed DBP verbally expressed higher levels of DFA[7].

Table 1. Types of fears in infant, child and adolescent period

Age	Types of fears
0-6 months	loud noises; loss of physical support
6-18 months	strangers; unknown situations; separation from parents; sudden and unexpected objects
2-3 years	animals; darkness; imaginary creations
3-6 years	darkness; storms; loss of close persons; body injuries
6-10 years	school; concern; darkness; body injuries and physical danger; loneliness; insects; supernatural beings
10-12 years	socialization; physical appearance; thunders and lightning
13-18 years	socialization; rejection from surroundings; physical appearance

After the contact with the stressor in the dental office the reaction pattern appears, which could be explained as follows[8]:

- some of the children show DBP, without DFA presence;
- some of the children understand DFA, know how to handle with the stressful situations, and are without DBP;
- some of the children have DFA presence with obvious DBP.

DBP that could appear in the dental office are just the manifestation of organic reactions activated after contact with the stressful factors able to cause DFA. DBP is defined as uncooperative behavior in the dental office, which results in delaying of treatment or no doing it at all[9]. Prevalence of DBP is about 9-10.5% in child and adolescent population[10]. DBP represents multifactorial model composed of personal (age, gender, temperament, emotional and behavior problems, cultural inheritance, general fear and anxiety presence, etc.) and situational factors (experience of pain and unpleasantness in the dental office, lack of control, inappropriate dentist behavior, etc.)[10].

In the developed stress-process, the key moment is the contact with the stressor itself in the dental office, as well as the way of individual reaction to it. This are the triggers from which it depends whether the DFA and DBP would appear in dental (child) patients. Individual reactions depend on stimulus intensity, as well as the ways of coping with stressful situations. Considering a fact that dental procedures are often stressful for children, coping with them could play important role in forming child experience in the dental office. *Lazarus* suggested two main reasons why person are willing to cope with the stressor, and they are the wish for controlling and changing the situations, and managing of emotional reactions. *Griffith* and associates divided abilities of coping with stressors to approach based (fight solution) and avoidant based (flight solution) options. Approach based coping ability is defined as acting in the direction of attempting to change the stressful situation in order to transform it to less irritating one. More precisely, the person recognizes the stressor and uses his/her skills to decrease the negative reactions to it. On the other side, avoidant based coping option is related to responses characterized with the lack of attempts for changing situations. This is the way to miss the active participation in stressor control and management, and the focus is directed to relaxation as much far away from the stimulus[11].

Above mentioned coping skills in the dental office are far more different and specific from various aspects in the child and adolescent period. After first confrontation they become learned ones. The way in which the child copes with the stressor for the first time is related to individual experiences, as well as those of the parents, family and friends. It has to be emphasized that coping patterns for one stimulus do not have to suit for another one. That is why this confrontation should not be observed from general but from situational context (special for each different stressor in every single situation). Medical stimuli are specific group of stress factors. Child cognitive capabilities, emotional responses, age-specific behavior, communication skills and psychological maturity have influence to their competence to understand and adequately react on invasive medical procedures[11]. It is also known that (younger) children are inured that their parents are struggling with the stressors instead of their offspring. However, the children are expected to cope with the medical stimuli themselves. The same case is with the dental stressors, where is determined that children developed specific coping patterns after the contact with them. These patterns are also depending from the child age and parents' influence. Recently, it is published that these DFA and DBP related coping skills could also be inheritable[12]. It is also known that these ways of confrontations to stimuli are simple and unified in younger children (they are the same for almost every different stressor). With growing, they are becoming more various and specific, and also cognitively orientated, and correspond to a single stimuli or a group of them. The parents influence is in the fact where in bringing up and growing of their offspring the children learn from and imitate their parents (and also their confrontation patterns and coping skills with stressful situations, including rationalization and relaxation). It is similar but smaller influence to the children from their family members and friends. Some authors also point out that coping skills are more or less related to patient gender, socioeconomic

state of their families, previous dental experiences, kind of dental treatment, psychological state of the person, DFA presence in their parents, etc.[11,13].

In the next part, few studies will be presented where the models of coping patterns with medical and dental stimuli were investigated.

Versloot and associates[14] defined three coping patterns: internal, external and destructive. Destructive strategies are unfavorable for dental treatment outcome (become angry, close the mouth). External strategies are about the use of some mechanical appliances or about presence of a person during confrontation with pain (outdoor, external help). Third group are strategies that need the internal help from the patient itself during confrontation with stressor. Children used the internal strategies most often than the external ones, while destructive strategies were used pretty rarely. Child patients with pain experience and DFA presence used the coping strategies more often, and those with DFA presence used internal patterns more often.

Van Muers and associates[11] stated that the examinees of their study used approximately 6.5 coping strategies, and the one most applied was „I'm doing what the dentist told me to" (in 91% of cases). The children considered that the most successful strategy was „I'm telling to myself that I have to do this, because it is good for my teeth" (in 92% of cases). Age differences in using of coping strategies were not determined. Otherwise, there were differences in the number of coping patterns between the patients with (bigger number) and without DFA presence.

Larochette and associates[15] investigated face expressions in children who experienced pain, comprising 46 kinds of facial muscles movements in total. Children showed three groups of facial expressions related to the caused pain stimulus, and they were fake, real and restrained ones. Authors showed that the children were capable to control their facial expressions when they were asked to do that. However, they were more capable to hide (restrain) pain feeling than to fake it. It is also shown that the parents are able to notice fake tries of their children. Otherwise, that was not the case with real and restrained child facial expressions.

Van Wijk and *Hoogstraten*[16] emphasized that the patients with DFA presence had the tendency to overestimate the pain they expected to be caused, and also to overestimate intensity of unpleasant happenings, such as fear. According to that, the patients who were predisposed to react frighteningly on pain had increased risk to end in the magic circle of anxiety, fear of pain and dental treatment avoiding. Similar findings also have *Versloot* and associates[17], and they added that the memory to previous dental experiences and earlier dental treatments probably had the great influence on the child dental behavior during the next dental visits. In case that the previous dental treatments were not stressful or invasive ones, that could lead to decreasing of showing of negative dental behaviors and also to decreasing of DFA expressions in patients with or without previous DFA presence. *Krikken* and *Veerkamp*[18] stated that subjective dental experiences during treatment in the dental office were more important than objective ones for DFA development. On the other hand, *Aoyagi-Naka* and associates[19] evaluated the level of psychological stress (more precisely, psychological reactions to stimuli) in patients who did not show DBP by measuring their α-amylase salivary levels before and after dental treatment. Authors determined that certain psychological reactions appear also in children without DBP expression during the process of coping with stimuli in the dental office.

Klingberg[10] stated in her study that is very important to have in mind the child's mental development and its psychological environment during conversation. Contextually, in psychological development of a child we must observe further:

- development of speaking abilities, which also implies ability of meaningful conversation with child patient, is possible already with the age 2.5-3 years, while use of grammar, negation and other more specific language skills is establishing later; we always must have in mind to make the conversation with the patients that is adopted according their age and mental and intellectual state;
- cognitive development, which is focused to child abilities for thinking and interpretation, and also to evolution of their learning and memory strategies;
- socioemotional and psychosocial development, focused to forming child character and their sense of representing inside their families, among friends and in the society;
- child temper, defined as emotional quality that differs individually, but is relatively stable during time.

The author states that there are clinical implications related to DFA, based on child psychological development. The pain, unpleasantness and anxiety are abstract phenomena and they demand the existence of advanced deduction as to be understood. Contextually, the problem is that general emotional state is wide and complex, and could be evaluated in many different ways. Child fears are changing while children grow in that way that younger ones have more fears, which they experience more intensively and in different ways than the older ones. That is why the pediatric dentist is responsible to treat the child patients on individual basis, to develop confidence in and towards patients, and to understand fear as normal child reaction to new unknown situations[10].

Freeman[20] suggests importance of investigating the role of the family, mother-child relationship, child psychological development and their life experiences in order to better understand and give the explanation why children react differently to dental treatment.

Before mentioned *Griffith's* division of coping skills implies existence of conflict in (child) dental patient regarding choice between approaching to and avoiding of the problem (approach-avoidance conflict)[21]. This model is explained in the way that two equal tendencies appear in the person as the answer to single situation. Based on this presumption, the person would like to reach the aim, and to avoid the problem at the same time. Contextually, we have the person who understands the need for dental treatment in order to have healthy teeth and nice looks, and that gives him/her motivation for dental office visits. At the same time, the same person is afraid of going to the dentist and he/she wants to avoid that experience. These two tendencies compete and create conflict in the patient. However, they are intensifying/weakening at the same time, depending on that how is person close/far away from the desired/frightened situation. Also, approaching-to-problem tendency is stronger as the person is more far away from the goal, while the situation is opposite as the person is closer to it by avoiding tendency emerging. The example for this should be getting the dental appointment. The person develops tendency of going to the dentist while the dental appointment date is far away. This tendency is strongest on the first day and weakens as the day of the dental visit is approaching. Opposite to that, the avoiding tendency, which was the weakest the first day, now intensifies (more and more) until the day of dental appointment. Based on this conflict we could divide dental patients to four categories[21]:

- apprehensive patients - this group is comprised of large number of patients who experienced some kind of DFA presence. Additionally, experienced presence of DFA is relatively moderate and does not lead to avoiding dental treatment, neither makes problems during the dental procedure itself. The fact is that DFA expression is raising as the dental appointment is closer. These patients show various coping skills during dental treatment, and are able to deal with DFA appearance and to mask its expression. Eventually they show signs of hyperactivity, curiosity or mild nervousness[21];
- patients who are visiting the dentist, but do not like to do that - this group feels DFA presence in a stronger way, has the more intensive component of avoiding problems, which strengthens more than in the apprehensive patients when the dental visiting day is closing by. However, these patients keep their word and are regular dental attendees. During the treatment they do not cope so well with DFA presence and are not able to mask it completely. They express more nervousness, less patience and some other elements of DBP, which could affect the duration of dental treatment more often than usual[21];
- patients who partially avoid dental visits - this group almost coincides with the previous one, except in the fact that their tendency of dental avoiding is a bit stronger and could lead to long period of dental visiting boycotting, which could often last several years. If the DFA presence is not managed in these patients, it is hard to expect that they would become regular dental attendees. The reason is that their approaching-to-problem tendency is pretty weak and that allows them to continue to avoid visits to dental office as long as it is possible. In some moment it could happen that they get motivation for going to dentist, mostly due to forcing of some family members or due to some oral health problem. This kind of situation extends dental treatment duration due to more extensive oral pathology as well as to DFA and DBP presence[21];
- patients who totally avoid dental visits - this group of patients avoid the dentist, no matter what is the real reason for that. The only situation when this kind of patient is in the dental office is when he/she suffers from urgent dental problem (mostly odontalgia). The avoiding tendency is so strong, and these patients would rather suffer (even if it is some kind of urgency), although the treatment would be even less painful than the problem they are scarifying for. This extreme and sometimes irrational kind of avoiding interferes normal daily functioning and could lead to emerging of dental phobia. It is very hard, and sometimes almost impossible to treat this kind of patients in the dental office. Additional reason for that is that they consider tooth extraction as the only possible dental procedure, but also try to escape from it. They easily manage to accomplish that, because they just vanish after the dental first aid is administered to them[21].

Factors Related to Parents of the Child Patients

A qualitative relationship between the therapist, parents and the child patient should be established for a successful dental treatment. It is obvious that every member of this partnership has equal duties for fulfilling the goal of oral health preservation, as well as administering every kind of dental procedures to any dental patient. Contextually, the role of the parents will be explained, especially because it is neglected by dentists and also by the parents[22].

The parents have to be aware that their actions are of the most importance and that they begin even before child birth. Future parents, especially the future mother, have to be introduced on time with the risks of cariogenic bacteria transmission to infants and also with the preventive measures administering in pregnancy and after birth. Parents also have to be motivated to

duly apply these measures. All of these precautions are important for preserving oral and milk teeth health from early days. If there were some oral health problems in these early periods of child development, dentists were often compelled to perform invasive or painful procedures mostly in preschool children in order to recover child oral health state. This early sanation of caries and its complications is one of the main reasons for DFA appearance, which later lead to DBP in the dental office. If parents do not take aforementioned important part in a sense of long term application of preventive measures to their children, the consequent complications are more serious, the treatments are more invasive and the reasons for DFA appearance are stronger[22-25].

Other important part that parents should take care is preparing their child for a dental treatment with agreement and advices of the dentist, especially in those children who express DBP. The methods are various, and mostly administered through the behavior and pain control management, as well as child upbringing. Sometimes this expected parents' role is durable and exhausting. Parents show resistance because they think that the dentist is the only person who will solve all their problems[22-25].

However, it is well known that parents form their children's behavior from the moment of their birth. This fact is the basis for our expectation from parents to prepare their children for the dental treatment. During preschool development, children learn what kinds of behavior are acceptable and/or forbidden. In that upbringing process, there are four types of parenting styles. The division is formed regarding parents demands and the expected responsibilities of their children[22-25].

Authoritative (democratic, balanced) parenting style - parents have high demands towards their children, but also show great responsibility to them. They set clear standards for their children, observe the installed boundaries and let the development of children autonomy. They expect the mature and independent age related behavior from their children. Bad behaviors are punished steadily and with consistence, without any despotism or violence. This kind of parenting style produces independent and self-confident children, who are happy, capable and successful. In the dental office they show normal child behavior. Cooperation with authoritative parents has the best results, including good preparations for dental treatment, good quality of planned treatment, as well as good long term colaboration[22-25].

Authoritarian (totalitarian, rigorous) parenting style is characterized with high demands towards their children, without any duty for high responsibility. Parents set high expectations and also the rules without much explanation. They only expect the respect and achieving the results from their children. If expectations are not accomplished, parents tend to punish their children rather than to explain the reasons for punishment, or to analyze child possibilities and needs. Children of rigorous parents have less self-confidence, because they are used to be told what the right choice is for them, and also how to behave. This kind of children are humble and obedient. In the dental office they mostly behave like the sustained or sometimes frightened child. Cooperation with this kind of parents can be a hard one. The reason is that they expect a lot from the others (their child, dentist) without any need for their own effort. They also consider that their own judgement is well enough for achieving of success[22-25].

Permisive (indulgent) parenting style is characterized with high self-responsibility, but weak demands towards their children. Permissive parents are very included in their children upbringing, they do not set the boundaries and fulfill every child demand. They do not demand situational appropriate behaviors, and they let their children to do everything. Children have no reason to learn to control their behavior, and they always expect to get what they want, and also show the problems with authorities. This kind of kids behaves in the dental office in uncontrolled way. Cooperation with permissive parents can be also a hard one. The reason is that qualitative relationship with the therapist could not be established. Active parenting role could not be fulfilled because these kind of parents are not used to demand something from their child. In some moments this could lead to misinterpreting things, because it seems that they are not trying enough, and sometimes they admit to be happy if the therapist would take over the role in child preparing for dental treatment. Oral health of children of permissive parents could be pretty bad, and this hardens the planning and performing the dental treatment[22-25].

Uninvolved parenting style shows low demands towards their children and low need for self-responsibility in offspring upbringing. The parents generally do not want to involve in their children's lives and do not set the boundaries. They also do not consider their children's opinions and feeling as important ones, and they do not offer any kind of emotional support. This kind of parenting style should be also considered as child abuse. The children of these parents show lack of self-confidence, self-control and competence related to their peers. They are able to express various forms of behavior in the dental office, including frightened, pretentious and sustained kind of patient. Cooperation with uninvolved parents is difficult, because they do not worry about what the dentist would like to achieve in the dental treatment. They think that it is well enough just to bring the child to the dental office. Oral health in these patients can be pretty bad, and together with the parenting style, additionally hardens dental treatment planning and administering[22-25].

Considering the contextual facts, it is sometimes necessary and desirable that parent(s) be present in the dental office. This happens in the cases where they do not worsen the child behavior with their appearance, or when they influence in that way where negative behaviors could

be fixed. In this kind of situations only one parent has to be present, because presence of many persons makes the situation more difficult and also creates tendency for developing negative behaviors. If parents insist to be in the dental office, they could do that until the autonomy of the therapist and the dental team in the process would not be compromised[25].

Factors Related to Dentist, Dental Team and the Dental Office

The main source of all problems that cause DFA and DBP appearance are the stimuli which are /in/directly related to the dentist, dental team and dental office. The study of *Oosterink* and associates[26] established 67 different stressors that directly and/or indirectly contributed to the appearance and/or engendering of DFA and DBP. The main carrier of all „problems" is the dentist itself, but the content of the dental office and other dental team members can also (sometimes) play important role in appearance and engendering of DFA and DBP.

The characteristics related to dentists are their own appearance (mostly white uniform), the way of their behavior during dental treatment, as well as paying attention to existence of a need for behavior and pain control management techniques administration in child patients during dental treatment[7].

Appearance of the health care personnel in white uniforms has general traditional unpopular influence. The term of health is often related to providing help in situations where the body integrity has been endangered in any way, and preventive aspect ignored. The dramatic aspect of health profession is intensified, because the conditions that demand any kind of treatment (including dental one) are often complex and request complicated and pretty unpleasant interventions. That kind of choice is always selected due to more benefits (better local and general health, saved life of the patients) despite the damages that could be made in the progress. This kind of situation produces negative perception in people for not only medical but also dental profession. The reason for this could be that sometimes the prime stressful agents are the dentists themselves. Moreover, the dental practitioners consider their profession more stressful than the other avocations[7,27,28].

The behavior of the dentists during the treatment is something that we are paying attention in theory as well as in practice. Everyday stress that follows dental profession is quite enormous and therapists should know how to deal with, and also not to let the patients to notice that they are under its constant influence. Special category are pediatric dentists as pediatric dental practice is (among others) about to predict the unpredictable, while performing very fast and precise manipulations in a small and narrowing oral environment. Any other kind of behavior of the dentists (except the professional one that is dictated by clinical situations) could even produce and/or engender of DFA and DBP appearance and development (for example, the fear that is present in the dentist, for any reason, inevitably leads to fear in the patient; nervous dentist could show lack of professional efficiency, which also could lead to his incompetence and mistrust by children and their parents). That is why the pediatric dentists have to be the masters of the nonverbal communication performance, and to learn how to improve the use of their body language as the asset for behavior management control in the dental office[7,29].

Today especially the child patients have need and every right to underwent to appropriate behavior and pain management control techniques administration during dental treatment[30]. The dental practitioner is the only responsible person (but also the most responsible one) who has to judge properly and timely which of these methods has to be applied in the clinical circumstances, starting from everyday use of non-pharmacological methods (for example tell-show-do approach, distraction, gradual desensitization) to rarely indicated dental treatments in general anesthesia. The reasons for non-administering (or administering of wrong) behavior management techniques are in the fact that there is not enough attention directed to detection of signs of DFA and DBP presence in child patients. These failures are due to underestimation of the situation (DFA and DBP do not exist, no matter what), or opposite overestimation (every „problematic" patient is at least a candidate for treatment under nitrous oxide sedation)[7,31].

Evaluation of DFA Presence Made by Child Examinees, Their Parents and Dentists (Observers)

Characteristics of DFA appearance regarding the mental maturity of the patients are various, especially in child patients. So, good evaluation of DFA presence becomes more complex. There are two ways of instruments application in studies of DFA presence in children[32,33]:

- indirect administering, where the observation is made by dentist or other person during the dental treatment, and
- direct administering, where the child itself (or with the help of mostly the mother) uses these instruments (psychometric scales for example). Contextually there are two versions of these kind of administering of the scales, depending who is using it: the child and the parental version.

Stallings and *March*[34] proposed that these instruments when administered to children and adolescents should: a) allow the reliable and valid measuring of symptoms, b) make the difference between the groups of symptoms, c) evaluate the severity of appearance, d) include multiple observations, and e) be sensitive towards changes in dentistry.

Finally, these measuring instruments for evaluation of DFA presence in children are divided to instruments for evaluation of patients behavior, psychometric scales, instruments for measuring of psychological parameters and projective scales (projective techniques)[32]. Every kind of quoted assets has its advantages and disadvantages, and these should be evaluated properly before the application of the instruments in clinical practice[7].

Psychometric scales: this is the most used kind of DFA evaluation assets characterized by simplicity of design and application. They comprise certain (smaller or bigger) number of stimuli for DFA and DBP appearance. Their greatest imperfection is their practical usage without certain dose of criticism. Mistakes are numerous[7]:

- non-determining the instruments for certain region of application before their usage - only after the normative values are properly determined and contextual results obtained, we would know if we do (or do not) have good assets for evaluation of DFA and DBP presence. The normative procedure is simply just like the calibration of any other measuring instrument before their first usage.
- random choosing of time and place of application (before or after the dental treatment, in the dental office, in the classroom, or in the house of examinees) - if we did not choose the place for administration for a reason, then we could not claim that the study had controlled environmental conditions. Home conditions are the most relaxed option for the examinees where the dental stressful stimuli are not present, but with possible parents influence on child judgement. School conditions are similar to previous, but also differ considering the phenomenon of a group and possible uncontrolled bias. Dental office conditions are ideal due to presence of almost all dental stimuli, but do not comprise the children who do not (in regular basis) attend there as a patients. This last alternative could lead to forming of non-representative sample.
- non-determining of age limit in children for these assets administration - depending on their age (younger!) children are not always capable to perceive and understand the things around them, nor to articulate them, neither to react to them properly. This should be under concern for children bellow 7 years of age.
- uncritical equalizing of usage of parent and child version of a scale - if it is not agreed or stated differently, it is not correct to automatically equalize the parent judgement of DFA and DBP presence in their children with child expression and self-evaluation of the same (this parent evaluation goes from under- to over-estimation of DFA and DBP presence in child patients).

Instruments for evaluation of patients behaviors - these DFA and DBP presence evaluation assets are used by trained persons (dentists mostly), and their judgement of objective evaluation affects to measuring accuracy of observed appearances. There are tendencies for detailed categorization of patient behavior in the dental office during the treatment (from extremely positive to extremely negative behaviors), but overlapping between these categories could often occur. Also, there is not always exact set border between positive and negative behaviors, neither instructions for their administering (whether it is about general evaluation during the whole dental treatment, or only some of the parts of it; do we notify only the most negative behavior despite to its arising, duration or causes)[7].

Instruments for measuring of psychological parameters - they occurred as an attempt for more objective judgement, and were based on proved existence of correlation between measurable indicators of body changes and reaction to stressful situations (blood pressure, pulse, amylase salivary levels, etc.). Although they were in a good way of progress in the beginnings, their practical application showed many imperfection with time. Besides economical aspects of their (non-) usage (additional space, financial and human resources are required), their administration often could cause higher levels of general fear and anxiety, with consecutive obtaining false positive results. That is why this method has more academic than practical application[7].

Projective scales – these kind of instruments have the narrowest practical implementation due to their design. They are limited to child patients of younger ages, and have suggestive nature with in advance determined scenarios and categories of (general) psychological states. They mostly were not created precisely, with the accent to attract the targeted population[7].

In the next final part, several studies will be presented where the parents-children relations in DFA presence evaluation were analyzed.

Luoto and associates[35] showed that fathers and mothers had weak knowledge about their children DFA presence, which improved as the offspring got older. On the other hand, they better recognized absence than the presence of DFA in a way that parents with DFA presence poorly recognized the same DFA presence in their children.

Gustaffson and associates[36] stated that results of parental and child version were in weak correlation, especially in children with DBP presence. That is why they proposed to further evaluate parents' judgement of DFA presence in their children, especially in the populations with high levels of DFA prevalence. Authors

recommended to use the child versions of the instruments as addition to parental versions.

Krikken and asociates[37] published the results of DFA evaluation where parents overestimated tendency with the few combinations: parents of children with DFA presence under-estimated these child DFA expressions, and completely adversely in children without DFA presence; parents with DFA presence overestimated the child judgements.

De Oliveira and associates[38] stated that mothers considered the reasons for DBP appearance in offspring to be child temper, behavior characteristics (hyperactivity, aweness, un-secureness, nervousness, anxiety, bossing, etc.), child developmental stage, mother presence in the dental office, and simple rejection of dental treatment.

Some authors investigated judgement of patient behavior during dental treatment from the dentist itself.

Wondimu and *Dahllof*[39] determined that almost half of the children were not capable to differ between pain and unpleasantness, while one third of them thought that the children reported pain in the dental office with certain level of un-secureness. Almost 35% of the dentists showed certain stage of non-interesting to pain experiences of the patients.

Murtomaa and associates[40] showed in their study that none of the groups of dentists did routinely examined the patients before the treatment regarding the pain, but rather during the treatment. Also, none of the dentists did evaluate dental treatment procedures as particularly painful or unpleasant ones. Majority of the dentists believed to the child statements about the pain, but also did not consider them as much credible ones.

Rasmussen and associates[41] claimed that only a quarter of the examinees did not consider complaints to pain of preschool children as precisely determined. 80% of them stated that they always wanted to provide completely painless treatment to their patients. Only some of them agreed that children forget pain faster than the adults. Almost 90% of the examinees said that they often or always use topical and local anesthesia during dental treatment.

Moore and *Brodsgaard*[41,42] investigated reasons for different ways of evaluating DFA and DBP presence in children and adolescents that were caused by dentists. Almost 92% of dentists considered that they usually or always noticed signs of DFA presence in their patients, while only 4% of them did not want or had not chance to treat the patients with DFA presence.

Some authors also published their results considering determined correlations and differences between the parent and child evaluation of DFA presence, and the same evaluation by the dentist-observer. *Klaassen* and associates[42] determined that there were no correlations in the results of evaluation of DFA and DBP presence between the parent and the dentist. *Araposthatis* and associates[43] determined the existence of statistically significant correlations between the negative child behavior and parental evaluation of child DFA presence. Similar results were published by *Yamada* and associates[44] and *Klingberg*[45].

When we observed the DFA presence in our recent study[7], there were statistically significant differences and correlations in the judgement of DFA and DBP presence between these three kinds of observers. The differences were determined between the child examinees and their parents (higher scores) and between the same examinees and the dentist (higher scores). On the other hand, statistically significant correlation in judgement of DFA presence was found between the all of three observers (the child examinees, their parents and the dentist). The correlation was the smallest and quite weak in the judgement between the children and their parents, while parents overestimated evaluation of their children. Correlation between child examinees and the dentist was quite higher and the best between the parent and the dentist. The thing was the same with analysis of measure of agreement values[7].

Note: The results of this paper were presented as a part of an invited lecture at the 21st BaSS Congress.

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Patient with Chronic Orofacial Pain in a Private Dental Office - Diagnostic Dilemmas

SUMMARY

Patients with chronic orofacial pain (COP), which means pain lasting almost always more than six months and serving no obvious purpose, very often present a quite diagnostic dilemmas. In some instances, this may especially create problem in a private dental office as various variants and manifestations of COP should be treated differently.

COP may have several clinical manifestations; however, it is usually classified in three basic categories: (1) ***neural pain****, caused by functional or structural irregularities within neural components; (2)* ***somatic pain****, caused by disturbances within the muscular/skeletal system; and (3)* ***atypical pain****, mainly caused by emotional stress and consequent changes of psychological response.*

Diagnosis and treatment of any kind of COP should be undertaken only after thorough and meticulous diagnostic procedures, preferably done multidisciplinary in institutions particularly orientated to the treatment of COP syndromes. Choice of treatment method should be directed to control the basic cause of chronic pain, which is ascertained by detailed clinical assessment, and fully adjusted to the particular needs of each patient. That is why the treatment of most frequent chronic orofacial syndromes - paroxysmal trigeminal neuralgia, temporomandibular joint pain dysfunction syndrome, and atypical pains - after diagnosis of chronic pain made in a private dental office, should be often, and preferably, done in institutions particularly orientated to the treatment of COP syndromes.

Keywords: Chronic orofacial pain; Paroxysmal Trigeminal Neuralgia; Temporomandibular Joint Pain Dysfunction Syndrome; Atypical Facial Pain

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Introduction

Pain is an unpleasant emotional experience resulting from either physical or psychological trauma. Painful experience includes not only a perception of sensations evoked by noxious stimuli, but also the reaction or response to such stimuli. Unless the patient is supposed to be a conscious malingerer or liar, the painful experience is always unpleasant and always real.

Orofacial pain is the most frequent reason patients seek dental attention. However, the precise diagnosis and successful treatment of orofacial pain is not always simple. In that respect, the greatest diagnostic (and also therapeutic) problem presents chronic pain, especially when there is no obvious organic cause (for example, malignant disease).

Pain of more than 6 months' duration is considered to be chronic. In contrast to acute pain, which serves a biologic purpose as either a protective mechanism or a warning signal, chronic pain does not serve any biologic purpose and appears to be intensified by psychological factors. In fact, chronic pain may be considered as a product of complex interaction of biologic and some behavioural factors, like for example bruxism habit or chronic muscle contraction, which significantly contribute to arising pain.

The patient's response to chronic pain is different from the response to acute pain and, for the majority,

the pain experience changes from day to day. Ongoing peripheral pathology is potentiated by psychological factors, such as social situations and emotional problems, which may cause an enhanced perception of pain. Some patients are able to cope with this continuous unpleasant perception and manage to live productive lives. This specific coping strategy does not appear to be associated with the severity of their pain, but is determined by their personality. When their coping mechanisms break down, however, patients may become depressed, disabled, and dependent on pain regardless the original event that started the pain problem. It is important to stress that these persons are often victims of several unnecessary and unsuccessful treatments, which include multiple drug misuse and unnecessary dental or surgical procedures.

Chronic orofacial pain may have different clinical presentations. However, all these conditions can be grouped into three main pain categories: ***neural pain***, caused by functional or structural irregularities within neural components (the most prominent model is paroxysmal trigeminal neuralgia), ***somatic pain***, caused by disturbances within the musculoskeletal system and neurovascular components (the most prominent model is so-called temporomandibular joint pain dysfunction syndrome), and ***atypical (psychogenic) pain***, mainly caused by emotional stress (the most prominent model is atypical facial neuralgia). Cancer pain may have chronic presentation but does not have all characteristics of chronic pain syndromes and does not produce diagnostic or therapeutic dilemmas.

Neural Pain

Neural pain is estimated to be caused by a functional abnormality within the nervous system. However, the exact etiopathogenetic mechanism is still not precisely determined for the most prominent representative of this chronic orofacial pain category - paroxysmal or idiopathic trigeminal neuralgia (PTN).

This syndrome occurs in middle age, mostly between forty and sixty, and is characterised by a severe stabbing or lancinating pain, lasting seconds, confined to one, or seldom two, divisions (commonly the second and third) of the right or left trigeminal nerve. The sensation resembles an electric shock or piercing with a sharp knife. Repeated attacks occur throughout the day, but rarely at night, and pain seldom disturbs sleep. The attack is characteristically provoked by otherwise non-painful stimuli of a precisely defined zone of the mucosa or skin, done by light touch during washing, shaving, talking, chewing or swallowing. This area is usually called a trigger zone. The disease is sometimes called “painful tic” due to merely reactive tic-like contraction of facial muscles during a pain attack.

Interestingly, immediately after the attack of pain, repeated stimuli do not provoke another attack, which means that there is a relatively short refractory period during which the attack cannot be provoked. Throughout the suffering, especially in the initial stage, there are periods of remission of pain, which get shorter with the progress of the disorder.

Diagnosis of PTN is based solely on clinical assessment of the symptoms, i.e. pain characteristics. There are no specific neurological signs or radiographic findings. However, the PTN should be distinguished from the same syndrome of other nerves, and especially from peripheral or central symptomatic trigeminal neuralgias, as pain characteristics are more or less different - the pain is more constant, and in the case of brain stem tumours compressing the trigeminal root, pain is soon accompanied by disturbance or loss of masticatory muscle function. Finally, PTN should be distinguished from other chronic orofacial pain syndromes, especially from atypical facial pain, as both syndromes may be present simultaneously, but alternatively.

The treatment of paroxysmal trigeminal neuralgia can be divided, generally speaking, into two modalities, medical and surgical, and possible treatment options should be discussed with each and every patient. The most effective medical remedy in the treatment of PTN is antiepileptic carbamazepine, the starting dose being usually 200 mg twice daily. The dose may be gradually increased to 1,200 mg per day in three divided-dose regimen. A beneficial effect is often apparent within a day or a few days after starting medication, and in doubtful cases, a positive response may help in diagnosing the syndrome. Unfortunately, there are several side-effects of carbamazepine treatment, including drowsiness, dizziness, unsteadiness, and similar, which are usually transient. The most serious side-effects are aplastic anaemia, agranulocytosis and allergy, and any of these necessitates withdrawal of the treatment. If there is a good response to the medication, it can be tapered off slowly over 4-6 weeks after the patient has been symptom-free for a few months. Some other anti-epileptics can also be used in case the medication with carbamazepine shows to be less efficient. The success in relieving pain with drug therapy places it first among treatment methods, giving the general dental practitioner a major opportunity to treat his patient himself.

A variety of surgical approaches has been advocated for the PTN treatment. Probably the simplest procedures are neural blocks with ethyl-alcohol or glycerol, which is organic alcohol, or neural blocks with combination of lidocaine and streptomycin. Pain relief is typically 6-18 months; but, during this period an unpleasant anaesthesia of the treated nerve lasts relatively long. After the anaesthesia wears off, a characteristic neuralgic pain soon returns.

Rhizotomy is a neurosurgical procedure by which selected nerve fibres within the Gasserian ganglion are destroyed. This is accomplished by placing a needle guided by radiography into the oval foramen of the sedated patient. After careful manipulation and feed-back from the patient, the selected nerve fibres can be destroyed by either radiofrequency thermo-coagulation, or cryosurgery. An alternative to rhizotomy is decompression of the trigeminal ganglion and dorsal root. This procedure involves a craniotomy in which the posterior fossa is opened and explored. The offending vessel responsible for compressing the nerve root, most commonly the superior cerebellar artery, is located, carefully separated from the trigeminal nerve and a sponge is placed between the structures. Remarkable immediate success follows this procedure. Although this neurosurgical procedure appears to have great long-term success, it is a major procedure, with accompanying morbidity and mortality. Selection of patients is therefore extremely important (the best candidates are relatively young and healthy patients, but as I previously said, the syndrome occurs in slightly older patients).

At the first visit after the diagnosis has been made, several treatment options should be discussed with the patient, indicating advantages and shortcomings, including side-effects of each. My own experience says that a vast majority of patients, possibly over 80% of them, choose drug therapy as the first treatment option, and the rest of them give priority to neural injection blocks, for different reasons, mainly due to the fact that they had already been treated unsuccessfully somewhere else and referred for injection blocks, or due to their specific occupation. As far as I can remember, no one has chosen neurosurgery; it only happened in a few intractable cases, after several years of treatment with carbamazepine or alcohol injections, when I, personally, suggested the neurosurgery option. However, one should not omit to eliminate any dental lesions and restore the occlusion as soon as the relief of neuralgic pain is gained. Simultaneous presence of temporomandibular joint pain may be difficult to distinguish from trigeminal neuralgia, and in some cases, appears even to provoke it. Therefore, both conditions should be treated simultaneously.

Somatic Pain – Temporomandibular Disorders

"Temporomandibular disorders" (or TMD) is a collective term that includes a number of clinical problems involving masticatory muscles and temporomandibular joints, and is synonymous with the term "craniomandibular disorders". TMD have been identified as a major cause of non-dental pain in the orofacial region and their management lies mainly in the realm of dentistry. Current research supports the view that they are a cluster of related disorders in the masticatory system with many common symptoms.

The most frequent presenting symptom is pain, usually located in the muscles of mastication, and/or the temporomandibular joint (TMJ). It is usually aggravated by chewing or other jaw functions. In addition to pain, patients frequently have limited or asymmetric mandibular movement and TMJ sounds that are most frequently described as clicking, popping, or crepitus. Protracted masticatory muscle hyperactivity and abnormal occlusal wear associated with oral parafunction, such as bruxism (jaw clenching and tooth grinding), may be related problems. Major disturbances in occlusion, especially loss of posterior occlusal support, may occasionally be present. Finally, TMD often coexist with other craniofacial and orofacial pain disorders - jaw-ache, earache, headache, and facial pain.

Nail biting or cheek/lip chewing are commonly associated with aforementioned symptoms as well. Finally, it is well recognised that emotional tension, regardless the source, may be expressed through facial muscular activity and bruxism, and may have an important role in the aetiology of pain. Each of these events may invariably have an adverse effect on TMJ function due to antero-medial dislocation of the TMJ disc after traction of the lateral pterygoid muscle. This causes an incongruence between articular surfaces and typical joint sounds - so-called clicks during function (mouth opening and closing). During mouth opening, a click-sound may be heard when condylar head leaps over the posterior band of the dislocated disc, continuing further movement congruently with the disc. While closing the mouth, the same click may be heard before the end of the condyle movement.

Diagnosis of temporomandibular disorders is based primarily on clinical assessment of the symptoms, i.e. pain characteristics. Thorough clinical examination is especially important, including TMJs (tenderness on palpation and during movements), and possible deviation of the mandible during opening. All the present teeth, restorations and occlusion should be examined carefully as well. Radiographs such as panoramic x-ray are useful for the survey of both the joints and dentition. However, dislocation of the disc may be demonstrated by arthrography only, if available.

Treatment of temporomandibular disorders may have several modalities, depending on the estimated primary cause. It is most important to deliver only essential dental care and restore an adequate occlusal support, especially if adequate posterior occlusal support is lacking. It is quite important to explain to the patient that emotional stress may generate muscular and joint pain through continuing muscle tension and bruxism. There are also benefits from specialised drug treatment, physiotherapy and even

surgery, but these modalities are not suitable for ordinary dental environment, and the patient should be referred to specialized institutions when judged that this might be beneficial.

Atypical Facial Pain

The third basic category of chronic orofacial pain belongs to the so-called atypical pains, which mean pains caused by emotional, i.e. psychogenic reasons. Although it may appear as a consequence of psychotic disturbances in depression or conversion symptom in psychiatric disorders, this kind of orofacial pain may arise in otherwise healthy persons due to emotional stress.

The main characteristic of this kind of chronic orofacial pain is the fact that it is impossible to detect any organic or functional cause for pain in the region where it is felt. Information from the early eighties say that probably 2-5% of all chronic pains belong to this category, although I think that this percent is much higher today in this area.

This kind of pain is often termed psychogenic as it usually appears after emotional stress; however, in front of the patient, it is better to refer to it as atypical, as the word „psychogenic“ can be understood by patients as pain is somehow fictitious.

Psychogenic facial pain may have several vague or distinct symptoms. Pain can be sharp, dull or throbbing, which is not confined to any single nerve distribution. It can be unilateral or even bilateral, of long standing duration, localized anywhere in the orofacial region, including teeth and jaws. On careful questioning, a history of migraine or vascular pains elsewhere is sometimes established. The most important feature is that many patients have suffered a predisposing adverse life event or emotional disturbance. Patients usually present with a history of tooth extractions, usually being unnecessary. After each tooth extraction, pain soon migrates to another tooth or persists at the extraction site.

Diagnosis of psychogenic orofacial pain is based primarily on thorough history and clinical examination to exclude any dental cause for the existing pain. It is important that no organic or functional reasons for pain can be found. Moreover, radiographic or laboratory tests are also negative. However, after careful and targeted questioning, anxious or depressive behaviour, after a lot of emotional problems, may be discovered.

Treatment of psychogenic orofacial pain is, generally speaking, similar to the treatment of temporomandibular disorders, probably due to the fact that both are strongly dependent to emotional stress. It should be focused toward counselling and explaining the cause of the problem. Unfortunately, some patients not only strongly resist a diagnosis of stress-induced pain and deny any emotional disturbance, but also insist on an organic diagnosis or suggest a need for tooth extraction. However, only essential dental care should be carried out, explaining the need for such treatment regardless the existing pain. It is important to explain to the patient that emotional stress may generate atypical pain due to influence of stress on levels of neurotransmitters in the central nervous system that control pain. There are also benefits from specialised drug treatment. However, as previously said, it is not suitable to suggest such medical treatment in general dental surgery, and the patient should be referred to a specialized institution.

Concluding Remarks

If one confronts the patient experiencing chronic facial pain in the general dentist’s office it is extremely important to be cautious and to start with meticulous history taking and clinical examination. It is especially important to ascertain the moment when the pain started. Unfortunately, in many cases, the patient is unable to reply precisely to that question. One should always have in mind that chronic pain, which is the consequence of any of the aforementioned syndromes, is not necessarily connected with organic diseases. For this reason, the practitioner should become acquainted with the possible causes of chronic pain, and any unnecessary dental procedure should be avoided, especially surgery without an obvious reason.

One should always have in mind that the best solution is a multi-disciplinary approach to the treatment of chronic orofacial pain, which can be offered in specialized institutions. Reasons for a multi-disciplinary approach to establishing the diagnosis and treating patients with chronic orofacial pain are several. First of all, a specialised clinic can provide complete and comprehensive diagnostics and treatment in the same place. Moreover, in an institution of that kind, various diagnostic procedures can be applied and several specialists can easily consult. There are also more opportunities for the selection of the most appropriate treatment, which will be individually orientated.

For multi-disciplinary treatment of chronic orofacial pain, the team of specialists may include specialists in oral surgery, oral medicine, prosthodontics, psychiatry, and others, when needed.

In conclusion, the treatment of most frequent chronic orofacial syndromes - such as PTN, TMD, and atypical pains - following diagnosis of chronic pain made in a private dental office, should be preferably carried out in dental clinics specialised in treating chronic orofacial pain syndromes. It is, therefore, advisable to refer the patient from a private dental office to such a specialised institution, especially in view of the fact that treatment

is complicated, success sometimes questionable and of long duration, which understandably is not acceptable for private dental practice for several reasons.

Note: The results of this paper were presented as a part of an invited lecture at the 21st BaSS Congress.

Further Reading

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Implant Therapy In The Esthetic Zone-Surgical Considerations

SUMMARY

Implant placement in the esthetic zone is a complex procedure and requires a restoration-driven approach. Proper selection of patients and implant together with individual assessment of the risk of esthetic complications are very important. Correct 3D-implant positioning and sufficient bone volume should provide long-term esthetic and function. Esthetic region is a zone in which expectations and possibilities collide. Clinician should bring the important decision on the appropriate time of implant placement. Immediate implant placement is particularly challenging in the esthetic zone. Patient desire for reduced treatment time should be weighed against the possible risk factors. Protocol of immediate implant placement in conditions of unfavourable gingival biotypes, the lack of bone or soft tissue in patients with a high smile line lead to esthetic failure which is very important in the esthetic region.

Key words: 3D-implant positioning, esthetic region, immediate implant placement

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Introduction

In the beginning of the application of dental implants in the oral rehabilitation of edentulous patients the main goal was to achieve osseointegration that would provide functional prosthetic solution. Today, long-term aesthetics together with functionality are integral parts of successful implant treatment outcome. Predictable esthetic result is of a particular importance in the esthetic zone defined as dentoalveolar segment that is visible upon full smile or any area of esthetic importance to the patient. Implant placement in the esthetic zone is a complex procedure that requires comprehensive preoperative planning and precise operative procedure based on restoration driven concept[1-3].

Patient selection

Preoperative analysis of edentulous site and assessment of general risk allow clinician to determine a potential of achieving successful esthetic outcome of implant treatment. General risk assessment includes medical status, periodontal susceptibility and smoking habits[1,3,4-7]. Smoking habits may jeopardize osseointegration, incorporation of bone or soft tissue grafts as well as stability of periimplant tissues. Heavy smokers consuming more than 10 cigarettes daily are at high risk of esthetic failure and cessation should be suggested prior to implant placement. Patients suffering from bone or immunologic disease, uncontrolled diabetes mellitus or those who are taking steroids, or with a history of irradiated therapy of jaw are high risk patients[4,5]. Active or refractory periodontal disease, poor oral hygiene and bruxism are associated with high risk[1,3,8].

High lip line allowing visibility of entire maxillary anterior teeth together with significant amount of supportive tissue represents great esthetic risk. This risk is associated with soft tissue and emergence profile esthetic failure and it even increases in cases with multiple tooth replacement. Thin gingiva biotype poses a risk of recession and soft tissue discoloration, often requiring periodontal surgery. Triangular shape of adjacent tooth and implant-supported restoration increase visibility of interproximal spaces (“black triangles”) and represent high risk for esthetic outcome[1].

Present or previous infection at/or adjacent to the future implant site is a risk factor for the esthetic result due to loss of bone and soft tissue. Crestal bone at adjacent teeth provides support for interproximal papilla leading to the esthetic appearance of implant supported restoration. Crestal bone loss at adjacent tooth resulting in the distance of 5.5 mm or greater to the contact point compromises esthetic result due to insufficient interproximal papilla. This problem is highlighted in extended edentulous spaces with multiple missing teeth, particularly at positions between the adjacent implants. Therefore, wide edentulous span with several adjacent teeth missing increases risk for esthetic failure, particularly when site of lateral incisor is included. Insufficient height and width of bone and soft tissues at future implant site disables correct 3D implant positioning and presents high risk of implant failure requiring site development through augmentation procedures. The most challenging situation is vertical deficiency of alveolar ridge and it is associated with the highest risk for the esthetic outcome. Finally, for the esthetic risk profile, it is important to assess patient-s esthetic expectations and whether they are realistic. For patients with high risk of esthetic failure, alternative restorative methods should be suggested[1,3].

Timing of implant placement

Following tooth extraction, implant can be placed immediately (Type 1), early after soft tissue healing (Type 2) or partial bone healing (Type 3), as well as after complete socket healing (Type 4). Clinician should bring the important decision on the appropriate time of implant placement. Patient desire for reduced treatment time should be weighed against the possible risk factors (Table 1)[2].

Table 1. Timing of implant placement following tooth extraction[2]

Classification	Advantages	Disadvantages
Type 1	• Extraction and implant placement are combined in the same surgical procedure • Reduced overall treatment time compared to types 2, 3, and 4 an implant in an ideal position • Peri-implant defects often present as two- or three-walled defects, which are favorable for simultaneous bone augmentation procedures	• Morphology of the site may increase the difficulty of placing • Morphology of the site may compromise initial implant stability • Lack of soft tissue volume makes attainment of tension-free primary closure more difficult • Increased risk of marginal mucosal recession • Inability to predict bone modeling may compromise outcomes
Type 2	• Reduced treatment time • Additional soft tissue volume allows for easier attainment of tension-free closure • Additional soft tissue volume may enhance soft tissue esthetic outcomes • Flattening of facial bone contours facilitates grafting of the facial surface of the bone • Peri-implant defects often present as two- or three-walled defects, which are favorable for simultaneous bone augmentation procedures • Allows for resolution of pathology associated with the extracted tooth	• Two surgical procedures are required • Morphology of the site may compromise initial implant stability
Type 3	• Partial bone healing usually allows implant stability to be more readily attained • Additional soft tissue volume allows for easier attainment of tension-free closure • Additional soft tissue volume may enhance soft tissue-esthetic outcomes • Peri-implant defects often present as two- or three-walled defects, which are favorable for simultaneous bone augmentation procedures • Flattening of facial bone contours facilitates grafting of the facial surface of the bone • Allows for resolution of pathology associated with the extracted tooth	• Two surgical procedures are required • Extended treatment time as compared to type 1 and type 2 placement • Socket walls exhibit varying amounts of resorption • Increased horizontal bone resorption may limit the volume of bone for implant placement

Type 4	• Bone healing usually allows implant stability to be readily attained • Additional soft tissue volume allows for easier attainment of tension-free closure • Additional soft tissue volume may enhance soft tissue esthetic outcomes and type 3 placement • Allows for resolution of pathology associated with the extracted tooth	• Two surgical procedures are required • Extended treatment time compared to type 1, type 2, • Socket walls exhibit greatest amounts of resorption • Greatest chance of increased bone resorption limiting the volume of bone for implant placement

The recommended protocol for the esthetic zone is Type 2 placement, 4 to 8 weeks following tooth extraction[1,2,9]. At that time the soft tissue is healed and a slight flattening of the buccal wall is present as a result of a bundle bone resorption (Figure 1a, 1b). The main aim of this protocol is the soft tissue healing that would provide its sufficient volume and the wide zone of keratinized mucosa allowing the primary tension-free closure following guided bone regeneration procedure. In this way risk of esthetic complications is minimized. This approach is suitable for the most cases with low to high esthetic risk. Deviation from this protocol is necessary in cases of large apical bone defects that compromise primary implant stability. In this situation, early implant placement with partial bone healing following 12 to 16 weeks (Type 3) is indicated[2]. Although newly formed bone in the extraction socket supports implant and provides sufficient primary stability, at the same time flattening of the facial bone wall occurs as a result of bone remodelling and requires contour augmentation using bone filler with slow resorption rate for acceptable esthetic result[1,2].

Figure 1a. Type 2 placement. Soft tissue healed allowing the primary tension-free closure following guided bone regeneration procedure

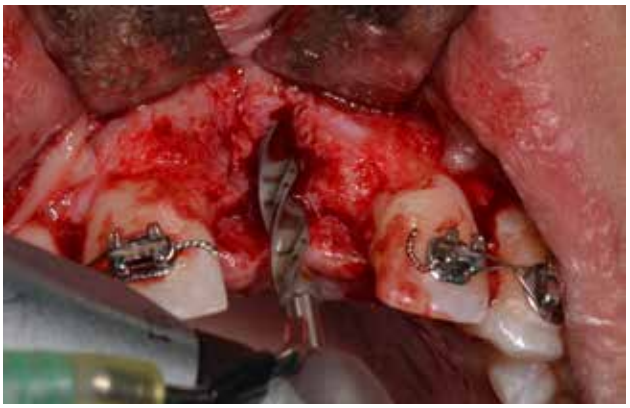

Figure 1b. Type 2 placement. Slight flattening of the buccal wall is present as a result of a bundle bone resorption.

Immediate implant placement is particularly challenging in the esthetic zone (Figure 2). Only limited number of patients with low esthetic risk, intact bone walls, thick facial bone wall (at least 1 mm), with no infection at the extraction site and bone volume providing sufficient primary implant stability, and are candidates for such approach[2]. Despite the reduced treatment time and optimal bone volume available for the implant placement, immediate protocol is associated with increased risk of gingival recession. Approximately 30 % of such sites have gingival recession of at least 1 mm[10]. Protocol of immediate implant placement in conditions of unfavourable gingival biotypes, the lack of bone or soft tissue in patients with a high smile line lead to esthetic failure which is very important in the esthetic region[1-3].

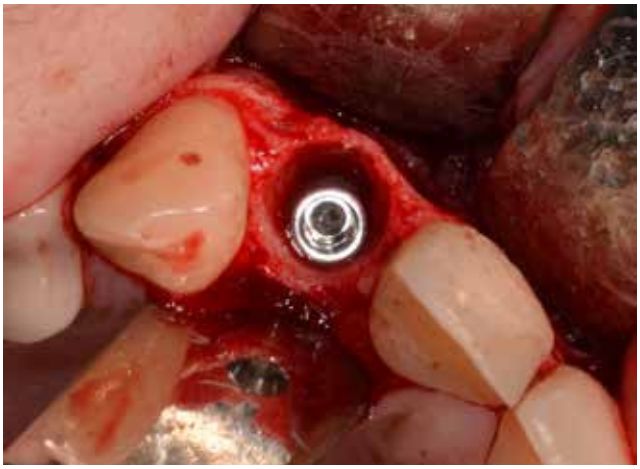

Figure 2. Immediate implant placement. Implant positioned in the fresh extraction socket.

Implant selection

Implant shape and size are determined by the site anatomy and future implant supported restoration[11,12]. Screw-type implants with micro and nano rough titanium surfaces provide predictable treatment outcome. Improved chemically modified surfaces with hydrophilic feature accelerate osseointegration and allow earlier implant loading[13]. Yttrium-partially stabilised tetragonal zirconia (Y-TZP) due to favourable esthetics, its flexural strength, high resistance to fracture and excellent osseointegration, might be an alternative[14,15]. For the regions of central incisor and canine where the tooth width is at least 7 mm regular neck implants are recommended whereas for lateral incisor region narrow neck implants should be used. Implants of reduced diameter with new titanium zirconium alloy that exhibit high mechanical resistance can be a viable alternative to extensive bone augmentation procedures. Wide-neck and wide-platform implants should be avoided in the esthetic zone since implant shoulder positioned to facially causes resorption of facial wall and gingival recession[1,3].

Number and distribution of implants in extended edentulous sites

Bone remodelling following tooth extraction reduces the width of the alveolar crest resulting in flattened ridge curvature. These changes are associated with reduced linear dimension of the ridge and affect number of implants needed for restauration. The main problem in extended edentulous sites in the esthetic zone is a lack of interimplant soft tissue between the two adjacent implants resulting in short interproximal papilla that represents obvious esthetic shortcoming. Therefore, maintenance of the bone that would provide support for interproximal papilla is of great importance. Proper number and distribution of implants have a great role in this issue. Following implant placement, circumferential vertical (of 2 mm) and horizontal (of 1.5 mm) bone loss from implant abutment level inevitably occurs to establish biological width. At radiograms it is represented as bone "saucer" around implant shoulder. When two adjacent implants are placed at distance less than 3 mm adjacent "saucers" will overlap and interproximal bone will resorb resulting in reduced height of papilla[1,3].

In the esthetic zone any two implants should be separated by pontics. Cases with two missing adjacent teeth are the most challenging. In the region of central incisors it could be overcome with two implants at a distance of at least 3 mm. However, in edentulous sites including lateral incisor, it is replaced by cantilever unit and implant should be placed in the region of central incisor or canine[3].

Implant positioning

Correct 3D implant positioning is essential for the long-term periimplant bone and soft tissue maintenance that would provide functional and esthetical restauration. In the mesio-distal dimension, implant shoulder should be at least 1.5 mm away from the root of the adjacent tooth in order to prevent resorption of the interproximal alveolar crest. Implant shoulder should be positioned about 1mm apically to the cemento-enamel junction of the adjacent teeth.In the orofacial dimension implant shoulder should be positioned about 1.5-2.0 mm palatally from the imaginary line connecting the point of emergence of adjacent teeth[1]. Proper implant alignment in orofacial dimension is especially challenging in immediate implant placement. In order to maintain sufficient thickness of the facial bone wall important for esthetic result, implant site should be prepared in palatal wall of the socket (Figure 2). However, dense palatal cortex guides drill towards the facial bone leading to implant malposition that will end up with gingival recession[1,2].

Implant malposition results in bone resorption and thin and deficient facial wall of the implant bed site or leads to gingival recession and prosthodontic complications related to restorations. Correct 3D implant position can be assessed preoperatively using CBCT and radiographic stent consisting of barium sulphate incorporated into the acrylic. In complex cases, where proper implant positioning is a challenge, such as in expanded edentulous area, the usage of conventional surgical template or guided-surgery guide is recommended. If bone deficiency disables correct implant positioning, augmentation procedures are mandatory[1,3,16].

Simultaneous versus staged approach

Dimensional changes of the alveolar ridge following tooth extraction or as a result of different pathological issues, usually requires bone augmentation procedures performed either simultaneously with the implant placement or using staged approach[2,4]. Although simultaneous approach is preferred due to reduced number of operations and reduced treatment time it is predictable only when favourable defect morphology exists i.e. at least two bony walls. In this clinical situation, present bony walls will provide osteogenic elements and supports bone substitute together with barrier membrane allowing predictable regenerative outcome (Figure 3). A residual alveolar ridge with crestal width less than 4 mm disables correct 3D implant positioning and requires staged approach using autologous block bone graft. For this purpose cortico-cancellous bone grafts are harvested

Figure 3. Guided bone regeneration performed simultaneously with the implant placement.

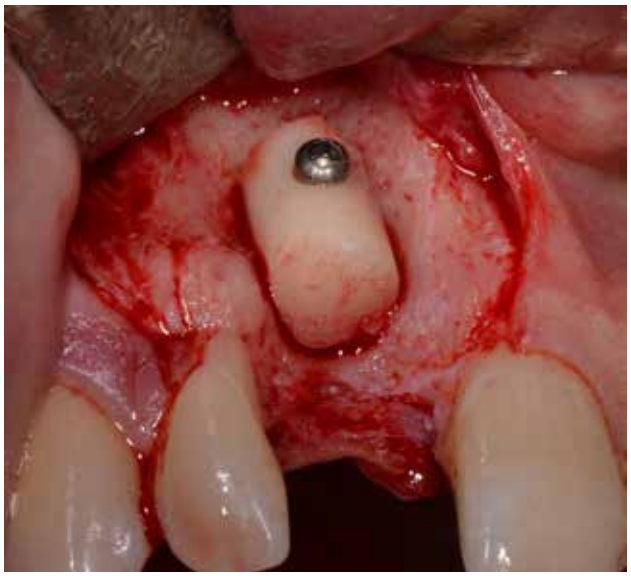

Figure 4a. Staged approach. Bone block harvested from retromolar area and fixed at the recipient site

Figure 4b. Staged approach. Implant placed in correct 3D position after 5 months of block bone graft healing.

from chin or retromolar area. Implant should be placed in correct 3D position after 5 months of healing in order to prevent graft resorption[16].

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Does Gender Influence Color Matching Quality?

SUMMARY

Objectives: *To compare shade matching skills of color normal males and females.*

Material and Methods: *A total of 174 dental students of both genders (117 females and 57 males, 20 to 25 years old), with no experience in color matching in dentistry, participated in the study. All recruited students passed the Ishihara color vision test for color deficiency, and matched the colors of eight shade tabs using VITA Linearguide 3D-Master shade guide. Standardized lighting conditions were provided using Rite-Lite (Addent Danbury, CT, USA) hand-held shade matching unit. Color differences between the task tabs and selected tabs were calculated using two CIE color difference formulae and students results were evaluated from 10 (for the best match score) to 1 for the 10th best match score. Means and standard deviations were determined. Student's t-test was used for result analysis (p = .05).*

Results: *The mean shade matching scores and standard deviations for male and female students were 5.86 (SD 1.38) and 6.10 (SD 1.36), respectively (p = .266). No statistically significant differences in overall and individual target tab scores by gender were recorded.*

Conclusion: *Within the limitation of this study, it was concluded that gender did not influence color matching quality.*

Keywords: color, dentistry, gender, shade matching, color-corrected light

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Introduction

Color could be the controlling factor in overall acceptance of a dental restoration by the patients[1]. Women have traditionally been considered to be better in matching colors than men[2], and this is certainly true when all females and males are compared, since approximately 8% of men (1 in 12 males) and only 0.5% of women (1 in 200 females) are color deficient[3]. However, research findings on color normal individuals are far from unison, ranging from supporting the traditional belief and reporting that females had significantly better results than males[4], to opposing it and reporting no gender-dependent differences in color matching[5-7].

Visual color assessment is a summation of individual responses to a color stimulus, and psychophysics is a scientific discipline dealing with mathematical relations between physical stimuli and sensations they cause[8]. Color difference is typically quantified using CIE (Commission Internationale de L'Eclairage - International Commission on Illumination) formulas: CIELAB (ΔE*) and CIEDE2000 (ΔE') [9]. While CIELAB formula is used more frequently, the CIEDE2000 is newer formula and it is recommended by CIE because of its better agreement with visual findings[10,11].

The quality of the color match between a dental restoration and the adjacent natural tooth is determined by magnitude and direction of the color difference. According to color science, practical interpretation of color differences for a given industry/application can be done through visual thresholds, in particular 50:50% perceptibility threshold (PT) and 50:50% acceptability

threshold (AT) [12-18]. The same is true for dentistry. At 50:50% PT, 50% of observers would notice a difference in color between two objects, while the remaining 50% would see no difference in color. At 50:50% AT, 50% of observers would accept a difference in color between two objects, while the remaining 50% would either correct color or make a new restoration.

Light is one of the most important factors for color perception - there is no color without light[19]. The daylight, D, is recommended for shade selection in dentistry[20]. CIE D illuminants are used to mimic various daylight conditions[9]. The "D" illuminants represent average daylight (natural, bluish white, daylight) and has a correlated color temperature from 5000-7500 K (D50, D55, D65, and D75) [21]. The color temperature of natural daylight exhibits a wide range, and it is therefore unreliable for color matching. It depends of weather conditions, time of year, time of day, color of sunlight, and other factors[22]. CIE daylight illuminants cannot be reproduced exactly in practice, so they are called daylight simulators, and they are used as an alternative in shade matching[23]. Color corrected lights, such as D55, ensure consistent and appropriate conditions for tooth color matching[2].

In addition to gender and light, several papers reported the influence (or lack of it) of experience, education, and age, on color matching results[24-26]. The same is true for color training programs, that can significantly improve one's color matching skills[24,27,28].

The aim of this study was to compare the results of male and female participants in determining color of different shade tabs under standardized lighting conditions. The null hypothesis was that there was no difference in quality of tooth color matching between color normal females and males.

Materials and Methods

A total of 174 dental students of both genders (117 females and 57 males, 20 to 25 years old), with no experience in color matching in dentistry, were recruited for the study. All students underwent the Ishihara color vision deficiency test and no color deficient individuals were found[29]. The study was approved by the Ethics Committee of the University of Niš, School of Medicine (No: 01-244-11). All students signed the informed consent form prior to participating in the project.

Basic instructions for using the VITA Linearguide 3D Master shade guide (LG, VITA Zahnfabrik, Bad Säckingen, Germany) were given. Students matched the shade task in two steps. In the first step they determined the group (0 to 5) using the tabs in the dark-gray holder. In the second step, they completed shade matching by selecting the best matching tab from the light-gray holder that corresponded to the group selected in step one.

Standardized lighting conditions were provided by using Rite-Lite hand-held shade matching unit (Rite-Lite, Addent Danbury, CT, USA), with a correlated color temperature of 5500°K and color rendering index, CRI ≥ 92 (Fig. 1).

Figure 1. Shade matching using Rite-Lite hand-held unit

The students' task was to match 8 shade tabs, for a total of 1392 shade matchings. Four task tabs were from Vita Linearguide 3D Master and four from VITA classical A1-D4 shade guide (VC, VITA). Therefore, there were four "exact match" LG task tabs: 1M2, 2L2.5, 3R1.5, and 4M2 and four "closest match" VC task tabs (exact matches not available): A1, B2, A3.5 and C4. A custom holder for the target tabs (task tabs that were matched with the shade guide) was made of SR Triplex Hot acrylic resin (Ivoclar Vivadent, Schaan, Liechtenstein). The holder was designed so that the shape and color resembles a human face (Fig. 1).

Color difference between the target tabs and selected tabs was calculated using two CIE color difference formulae, CIELAB and CIEDE2000 as follows[9-11]:

$$\Delta E^*_{ab} = \sqrt{(L^*_2 + L^*_1)^2 + (a^*_2 + a^*_1)^2 + (b^*_2 + b^*_1)^2},$$

where ΔE* is difference in lightness-darkness, while Δa*, and Δb* are the differences in green–red and blue-yellow coordinate, respectively.

$$\Delta E^*_{00} = \sqrt{\left(\frac{\Delta L'}{K_L S_L}\right)^2 + \left(\frac{\Delta C'}{K_C S_C}\right)^2 + \left(\frac{\Delta H'}{K_H S_H}\right)^2 + R_T \frac{\Delta C'}{K_C S_C}\frac{\Delta H'}{K_H S_H}},$$

where $\Delta L'$, $\Delta C'$, $\Delta H'$ are metric differences between the corresponding values of the samples, and $K_C S_C$, $K_C S_C$ and $K_H S_H$ are empirical terms used for correcting the metric differences to the CIEDE2000 differences for each coordinate[30].

If the best match was selected (VC shade tab with the smallest color difference or the exact LG tab), student was given 10 points, if the 2nd best match was selected, they obtained 9 points, the 3rd best match corresponded to 8 points, and so on up to 1 point if the 10th best match was selected. Any color match worse than the 10th best match was given 0 points.

Means and standard deviations were determined. Statistical significance of differences by gender was calculated using Student's t-test (SPSS v17 for Windows; IBM, New York, NY, USA) at $\alpha = .05$.

Results

The total scores for male and female were 5.86 (±1.38) and 6.10 (±1.36). No statistically significant difference was recorded ($p = .266$).

Shade matching scores for exact match (LG target tabs) and closest match tasks (VC target tabs) are presented in table 1. The mean scores, standard deviations and significance for each individual target tab are shown in table 2. No significant differences by gender were recorded for any of these comparisons.

Table 1. Mean scores, standard deviations (SD) and significance for male (M) and female (F) observers for the exact match task tabs (3D) and the closest match task tabs (VC).

	Gender	N	Scores	SD	p
LG	M	57	5.49	2.07	.237
	F	117	5.87	1.93	
VC	M	57	6.23	1.33	.630
	F	117	6.34	1.52	

Table 2. Mean scores, standard deviations (SD) and significance for male (M) and female (F) observers for each of target tabs.

Target Tab	Gender	N	Scores	SD	p
1M2	M	57	7.32	2.84	.644
	F	117	7.53	2.87	
2L2.5	M	57	4.74	3.49	.928
	F	117	4.79	3.35	
3R1.5	M	57	4.82	3.30	.269
	F	117	5.43	3.40	
4M2	M	57	5.07	3.21	.216
	F	117	5.72	3.24	
A1	M	57	6.82	1.21	.020
	F	117	7.32	1.36	
B2	M	57	5.33	3.30	.413
	F	117	5.74	2.90	
A3.5	M	57	7.16	3.18	.836
	F	117	7.26	2.81	
C4	M	57	5.60	2.73	.259
	F	117	5.05	3.10	

Students achieved the best scores for 1M2 and A3.5 task tabs. The worst score was achieved for the task tab 2L2.5.

The correlation between color differences in CIELAB and CIEDE2000 was $R^2 = .97$ for both exact and closest match task tabs. The equation for estimating ΔE' values based on the known ΔE* values was as follows: $\Delta E' = 0.63 \times \Delta E^* + 0.14$, while the equation for estimating ΔE* values based on the known ΔE'** values was as follows: $\Delta E^* = 1.49 \times \Delta E' + 0.02$.

Table 3. Color differences (SD) according to CIELAB (ΔE) and CIEDE2000 (ΔE') for the exact match task tabs (3D) and the closest match task tabs (VC)*

Points	ΔE*, 3D	ΔE', 3D	ΔE*, VC	ΔE', VC
10	0.0 (0.0)	0.0 (0.0)	2.5 (1.0)	1.9 (0.6)
9	2.2 (2.1)	1.5 (1.4)	3.1 (1.0)	2.0 (0.5)
8	3.6 (1.2)	2.3 (1.0)	3.7 (1.2)	2.9 (1.0)
7	4.5 (1.7)	3.4 (1.0)	4.6 (1.0)	3.2 (1.0)
6	5.1 (1.7)	3.5 (1.3)	4.7 (1.0)	3.2 (1.0)
5	5.3 (1.7)	3.5 (1.1)	5.0 (1.0)	3.3 (0.8)
4	5.6 (1.5)	3.6 (1.2)	6.1 (1.9)	4.0 (1.2)
3	5.7 (1.5)	4.0 (0.8)	6.2 (1.8)	4.1 (1.3)
2	6.6 (1.6)	3.9 (1.3)	6.9 (1.6)	4.5 (1.5)
1	6.8 (1.6)	4.3 (1.0)	7.1 (1.6)	5.3 (1.5)

* CIEDE2000 differences were calculated based on CIELAB order of matches

Discussion

As there was no statistically significant difference in quality of tooth color matching between color normal males and females, the null research hypotheses was accepted.

It is a traditional belief that women are more capable of matching colors than men. The fact that color deficiency is more frequent in males did not affect the results of the study, because all recruited students were color normal. In humans, two cone cell pigment genes are present on the X chromosome. If women are heterozygous they could be tetra-chromatic, which may provide them with an additional advantage in shade matching[31-34]. It was reported that that gender played an important role in shade matching, and females achieved significantly better results than males[4]. On the other hand, numerous studies showed that no gender-dependent difference in shade matching ability between genders[2,5,6,19,28,35-37].

When ten observers match 48 shade tabs of three VC shade guides under D65 and D50 lights and different

colors of background/surround, it was found that the influence of gender had no statistically significance on shade matching results[19]. In another study 20 male and 20 female dental technicians matched 10 VC target tabs using a commercially available light source. There were no significant differences between scores by gender. The study showed that dental laboratory technicians achieved better shade-matching results with the commercial corrected light source than under the usual lighting conditions in the dental laboratories[6].

Another report stated that gender and experience did not influence shade matching skills. A total of 165 male and 51 female students participated in this study. It was concluded that gender had no effect on shades matching ability and that dental students matched shades significantly better with a corrected light source than under natural light[7].

Some authors suggested that north natural daylight in late morning provides the best lighting conditions for shade matching, and D50 was one of the illuminants they used. They did not find statistically significant difference between genders[24]. Light sources can play a crucial role in shade matching. When a pair of different colors match under lighting conditions and mismatch under another, this phenomenon is called metamerism, which can also be defined as a conditional or non-spectral match[38].

In the present study, students used the Rite-Lite Shade Matching Light with a correlated color temperature of 5500 °K. Overall, results for exact (LG) and more demanding closest (VC) match, and results for each individual task tab did not show statistically significant difference between females and males.

Target tabs with a variety in lightness (medium-light. medium-dark. and dark) were selected for the experiment[39]. Best results for LG task tabs were achieved for 1M2. The 2L2.5 scores were the lowest of all task tabs. One explanation for such a low score could be extreme error by some students (as standard deviation was very high). Another reason could be the presence of a large number of similar shades in this part of tooth color space. Some authors obtained low average scores for shade 2L1.5 and reported that older participants with more-professional experience may have matched shade 2L1.5 with greater success[41]. As far as the VC task tabs are concerned, the best result was achieved for A3.5. It is interesting to note that the smallest standard deviation was recorded for the A1 task tab.

There were no statistically significant differences between genders at any of the stated tasks.

Color differences in dentistry could be presented with two major visual thresholds: the 50:50% perceptibility threshold (PT) and 50:50% acceptability threshold (AT). A recent study reported the CIELAB (ΔE*) 50:50% PT of 1.2 and 50:50% AT of 2.7. Corresponding CIEDE2000 (ΔE') values were 0.8 and 1.8, respectively[17]. The first and second LG best match (10 and 9 points, respectively) and the best match for VC, were lower than 50:50% AT in both CIELAB and CIEDE2000. However, the average score for all students was 6.0, which is the 5th best match (in average, there were four better matches than the selected one). The mean color differences between the task tabs and the 5th best match were ΔE*=4.9 and ΔE'=3.4, which were much higher than the 50:50% AT. This raises a red flag and underlines the need for implementation of color education and training programs in dental schools and continuing education for dental professionals[42,43]. Furthermore, significant education and training-dependent improvements were reported in two recent publications[28,44].

Conclusion

Within the limitations of this study, it was concluded that:

- There were no statistically significant difference in color matching skills of color normal males and females. This encompasses the overall scores, type of task (exact/closest match), and the results for the individual shade tabs;
- The average score, corresponding to 5th best match, underlined the need for implementation of color education and training programs in dental schools and continuing education for dental professionals.

Note: The results of this paper were presented as a part of an invited lecture at the 21st BaSS Congress.

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High Crown to Implant Ratio as Stress Factor in Short Implants Therapy

SUMMARY

Background/Aim: *The purpose of this study was to report the outcomes of crown to implant ratio (C/IR) measurements of single-tooth short implants. The specific aim of this study was to evaluate the effect of C/IR on crestal bone loss, assessing the success of short locking-taper implants treatment.*

Materials and Methods*: The cohort study was based on a sample of 33 patients, 14 males and 19 females. They were treated by at least one hydroxyapatite-coated Bicon implant, restored with Integrated Abutment Crown cementless technique and porcelain fused to metal crowns. The study was conducted between 2010 and 2015. Patients were recalled after 1-year and 2-year period time. Periapical, panoramic radiographs and clinical photos were obtained. The outcome measures were C/IR, crestal bone levels and the success of short implants therapy.*

Results*: After all the measurements were done on the first day of implant loading and at last visit, the mean C/IR was 1.85 (range, 0.95 to 3.20) and the mean change in the mesio-distal crestal bone levels was -0.73mm. No significant correlation was found between the C/IR and the risk for crestal bone loss nor the risk for implant failure.*

Conclusions: *A high C/IR has no significant effect on crestal bone levels (r= -0.151, p= 0.230) and on failure of implant treatment (p= 0.631) after the insertion of single-tooth locking-taper and implant restorations.*

Keywords: crown-to-implant ratio; short implants; integrated abutment crowns

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Introduction

The effect of a high crown to implant ratio (C/IR) on single tooth locking-taper screwless implants is an often discussed issue among clinicians. It is well known that the ratio between the crown and root (C/RR) of the natural tooth is 0.5 (1/2). However, the ideal C/IR is not established yet[1].

The greater the crown height, the greater the moment of force or lever arm with any lateral forces[2,3]. Forces may be increased by 20% for every 1 mm of the increase in crown height[4,5]. A high C/IR will introduce significant moment arms on the implant and surrounding crestal bone when the implant restoration is subjected to lateral forces[2]. The greater the moment of force, the greater stress of alveolar ridge would be, leading to crestal bone loss[2]. Clinical studies have not established a significant correlation between high C/IR and crestal bone loss on single-tooth implant restorations[1]. The effect of the high C/IR on single-tooth locking-taper screwless Bicon implants has not been evaluated yet[1].

The purpose of this study was to report the outcomes of the C/IR measurements. The specific aim of this study was to evaluate the effect of C/IR on crestal bone loss, assessing the success of short locking-taper implants treatment.

Materials and Methods

Study Design

The present study included a total of 33 subjects, 14 males and 19 females, who had at least one hydroxyapatite-coated Bicon implant, placed between

2010 and 2015, mostly restored with a single-tooth Integrated Abutment Crown (IAC)[6]. The IAC is a technique in which a single-tooth implant is loaded with a cementless restoration, in which the abutment and the crown are a single unit. The connection between the implant and the abutment-crown complex (unit) is a locking-taper or cold welding mechanism[7,8]. Patients were recalled after 1-year and 2-year period. Periapical and panoramic radiographs, as well as clinical photos were obtained. The intraoral radiographs (MyRay-ZEN-X, 5VDC USB 500mA) were taken with the use of long-cone technique and MyRay Sensor Positioning System (parallel technique) to optimize projection geometry.

To calibrate the measurements, the length of the implant was measured using the intraoral radiograph measuring the distance from the implant abutment interface to the apex of the implant - measured implant length (MIL). The actual implant length (AIL) was available from the manufacturer. The margin of error was calculated by the ratio AIL/MIL.

To adjust measurements for calibration error, the digital measurements were replied by the margin of error for that radiograph.

Study Variables

1. **Crown-to-implant ratio (C/IR)**[1]: The endosteal implant height (EIH) was calculated from the first bone-to-implant contact (FBIC) to the apex of the implant on both mesial and distal sides and, therefore, only the implant height situated within bone was taken into account for the calculation of C/IR.
   The supraosteal crown height (CH) was assessed from the most incisal or occlusal point of the crown to the FBIC on both mesial and distal sides, in millimetres. Thus the crown, implant abutment and implant surface located coronal to the FBIC were included in the determination of CH. To acquire the mesial C/IR, the mesial CH was divided by the mesial EIH. The distal C/IR was also determined, and then an average mesiodistal C/IR (avC/IR) was measured for each implant (Figure 1).

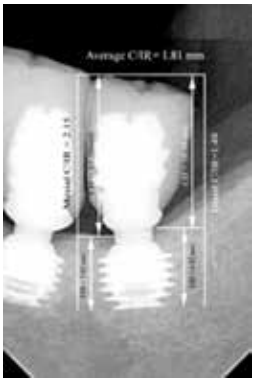

Figure 1. To obtain C/IR, endosteal implant height (EIH) divided by supraosteal crown height (CH) on both mesial and distal sides. An average mesiodistal C/IR was obtained per implant restoration

2. **Demographics**: The patient's gender and age were recorded at the moment of implant placement.
3. **General health status**: General health of the patients was classified according to the American Society of Anesthesiology (ASA) system[9]. Patients were categorized as ASA I (healthy) and ASA II (mild systemic disease).
4. **Current tobacco use**: Yes or No.
5. **Anatomic considerations**: In this category we included tooth type (incisor, canine, premolar, molar) and the implant position (maxilla, mandible, anterior, posterior).
6. **Type of bone**: Type of bone was assessed according to Misch[10] (D1, D2, D3, D4).
7. **Adjacent structures**: The proximity of the implant relative to teeth or other implants: The following categories were used: no teeth, one natural tooth, two natural teeth, one implant, two implants and one natural tooth/one implant.
8. **Crestal bone levels:** The crestal bone changes were obtained from the intraoral radiographs (periapicals) on the day of the insertion of the definitive restoration, 1-year and 2-years after loading. The radiographs were taken with a parallel technique to optimize projection geometry. Crestal bone levels (CBL) were measured mesially and distally. The linear measurements were obtained from the implant-abutment interface (IAI). A positive number suggested an increase in crestal bone level. A negative number suggested a bone loss overtime.
9. **Implant failure**: Failure was defined as a need for removal of the implant.

Results

The sample consisted of 33 patients, 14 males (42.42%) and 19 females (57.58%), mean of age (47.87±14.97). A total of 66 Bicon implants were placed: 60 implants (90.91%) in the posterior areas and 6 (9,09%) in anterior areas, which were restored with 59 Integrated abutment Crowns and 6 single-tooth metal-ceramic crowns. The most common location for all implants was the posterior mandible with 32 implants (48.5%), posterior maxilla with 27 implants (40.91%), followed by anterior maxilla with 6 implants (9.1%). No implants were placed at the anterior mandible.

Thirty patients were categorized as ASA I (90.91%) and 3 patients were categorized as ASA II (9.09%). The distribution of samples according to tobacco use - 6 of patients were smokers (18.18%) and 27 of them were non-smokers (81.82%). One implant was placed in D2 bone (1.51%), 43 implants (65.15%) in D3 bone and 21 implants (31.82%) in D4 bone. Two implants (3.0%) were adjacent by one tooth, 24 implants (36.4%) were adjacent by two teeth, 9 implants (13.6%) by one implant, 10

implants (15.2%) by two implants and 20 implants (30.3 %) were adjacent by one tooth/one implant. The follow up for all the implants were 24 months (Figure 2).

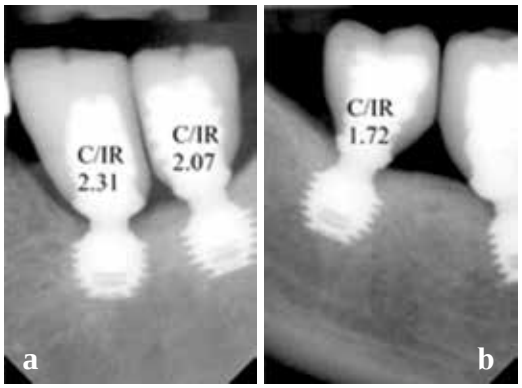

Figure 2a and 2b: Crown insertion

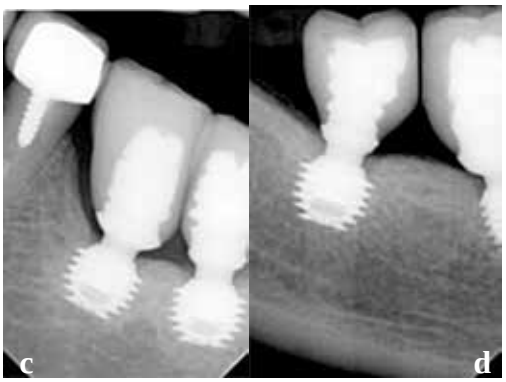

Figure 2c and 2d: Periapical radiographs after 2 years

Figure 2e and 2f: Clinical photos of IACs 36, 37 and 46, 47

During this study, two implant failures were documented. One implant placed in a smoker patient (cigarettes), with agenesis of two maxillary laterals, failed after loading. The implant was replaced after 5 months, without further complications. The other failed implant was placed in the posterior mandible in a non-smoker patient. It failed after insertion of the Integrated Abutment Crown and was no longer replaced.

Correlation between C/IR and Clinical Variables

Based on the Kendal's tau correlation coefficient, there was no significant correlation between the outcome and variables as: gender (p= 0.472), health status (p= 0.268), tobacco use (p= 0.352), bone quality (p= 0.376), adjacent structures (p= 0.562) and treatment result (p= 0.631). Based on the Kendal's correlation coefficient, there was a statistically significant correlation between the average of C/IR and patient's age (r=0.335, p=0.006) (Figure 3).

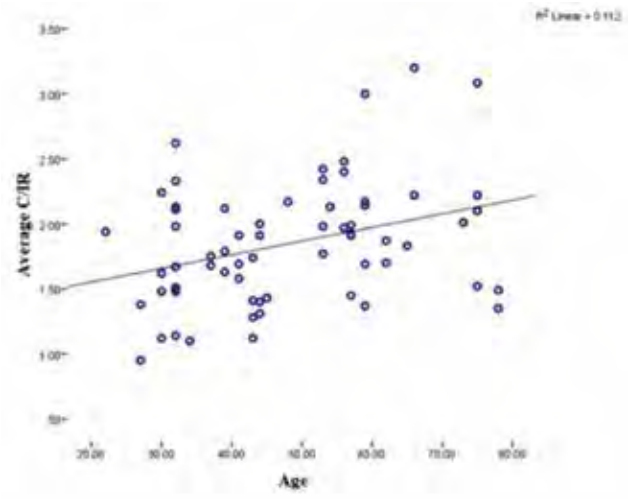

Figure 3. The correlation between the average C/IR and patient's age

Based on the Kendal's tau correlation coefficient, there was no statistically significant correlation between the C/IR and the treatment results. The average C/IR was 1.85 (range 0.95 to 3.20) (Figure 2). The average value of crestal bone level after loading was 0.5 mm and the average value of crestal bone level at the last visit was -0.23 mm. The mean mesio-distal change in crestal bone levels was -0.73 mm during 2 years of follow up. Based on the Pearson's correlation coefficient, there was no statistically significant correlation between the average value of C/IR and the mean mesio-distal change of crestal bone levels (r= -0.151, p=0.230).

Discussion

It has been proposed by Misch, that the higher the crestal stress, the higher the risk of crestal bone loss, and the higher the stress factor throughout the implant, the greater the risk for implant failure[11]. Increasing C/IR amplifies the moment arm for any offset occlusal loads[2].

Some studies of splinted external-hex machined-surface implants have detected increased peri-implant bone loss related to stress from superstructure design and parafunctions[12,13]. Different studies have reported reduced bone loss in cases of increased stress from larger C/IR's on single-tooth sintered porous-surface implants[14].

In other investigations increased C/IR did not lead to an increased risk of crestal bone loss or to an increase in implant failures or crown failures, after the insertion of single-tooth locking-taper implants restorations[1,15]. Evidence indicates that further studies should be conducted in order to estimate the effect of mechanical overload on peri-implant bone around single-tooth implants of different designs.

According to Brånemark, acceptable bone loss in the first year after the implant placement is 1-1.5 mm and 0.2 mm after the first year. The results of this study confirm that C/IR is not a significant risk factor for the crestal bone loss (0,73 mm after two years) after the insertion of single tooth locking-taper implant restorations. There was a significant correlation between the average of C/IR and the patient's age (p=0.006, r=0.335). In older patients, the C/IR was higher, which indicates the reduction of the alveolar crest and a higher clinical crown. In clinical cases like this we may use shorter implants in areas that have limited bone available instead of a long implants. The clinical significance of this finding is that locking-taper screwless implants may be restored with single tooth restorations while the clinical crown length is almost twice longer the clinical implant length or 3.7 times the crown-to-root ratio of the natural tooth. Resolving cases with short implants when limited bone is available, reduces need for sinus lift, bone augmentation, grafting and other surgical procedures[15] that involve complications, time and money.

A high C/IR did not lead to a statistically significant increase in implant failure. This results are consistent with the results of other researches; Schulte et al.[16] reported 16 failures of 889 locking-taper single-tooth implants and concluded that there was no clinically significant difference beetwen C/IR of the implants that were in function and those implants that failed. Urdaneta et al. concluded that larger C/IR (up to 4.95) was associated with a significant increase in prosthetic complications but had no significant effect on crestal bone levels on single-tooth locking-taper implants[1]. Their study showed that increased C/IR had a significant effect on the loosening of maxillary anterior of IACs and in the fractures of 2-mm-wide titanium abutment posts used for restorations in posterior areas. The results of Urdaneta et al.[1] supported the hypotheses that the longer occlusal high moment arm, resulting from larger C/IR, might have increased microrotation/rocking[2] and might lead to the lossening of maxillary anterior IACs and the fracture of 2-mm-wide titanium abutment posts. These complications could be avoided by splinting multiple adjacent implants. Splinting implants increases resistance to lateral loads, decreases the risk of implant's component fractures[17] and reduces abutment screw loosening and screw-retained implant restorations[18]. Taking in consideration screw-retained implant systems, it is possible that increased C/IR could play a significant role in a screw loosening or screw fracture, since both prosthetics and abutment screws have a smaller cross-sectional area than implants (typically about 2 mm)[11, 19].

Thus, when making treatment plan respecting the areas with a very high C/IR, splinting of multiple implants and using implant components wider than 2-mm should be taken into consideration as treatment option.

Conclusions

A higher crown-to-implant ratio did not lead to a high risk of crestal bone loss or to an increase in implant failures after the insertion of single-tooth locking taper restorations. The clinical significance of this finding is that locking-taper screwless implants maybe restored with single tooth restorations when the clinical crown length is almost twice longer then the clinical implant length, or 3.7 times the crown-to-root ratio of the natural tooth, or when the clinical crown length is up to 3.2 times the clinical implant length.

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Fracture Resistance of Composite Veneers with Different Preparation Designs

SUMMARY

***Background**: The aim of this in vitro study was to examine the fracture load of composite veneers using three different preparation designs.* ***Material and methods**: Fifteen extracted, intact, human maxillary central incisors were selected. Teeth were divided into three groups with different preparation design: 1) feather preparation, 2) bevel preparation, and 3) incisal overlap- palatal chamfer. Teeth were restored with composite veneers, and the specimens were loaded to failure. The localization of the fracture was recorded as incisal, gingival or combined.* ***Results**: Composite veneers with incisal overlap – palatal chamfer showed higher fracture resistance compared to feather preparation and bevel preparation. The mean (SD) fracture loads were: Group 1: 100.6±8.0 N, Group 2: 107.4±6.8 N, and Group 3: 122.0±8.8 N. The most common mode of failure was debonding for veneers with feather preparation and fracture when incisal edge is reduced. The most frequent localization of fracture was incisal.* ***Conclusion**: The type of preparation has a significant effect on fracture load for composite veneers. This study indicates that using an incisal overlap– palatal chamfer preparation design significantly increases the fracture resistance compared to feather and bevel preparation designs.*

Key words: composite veneers, preparation design, fracture resistance

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Introduction

Patients' desire for aesthetic correction of the front teeth is constantly growing. There is increased number of patients with aesthetic demands. Advances in technology and dental materials provide us many alternatives and options in order to improve their smile and eliminate aesthetic disadvantages, such as: discolored teeth or crooked, chipped, broken teeth or median diastema[1,2]. There are many ways to re-establish bio-aesthetic relation and composite veneers are one of them. Simple technology, high aesthetics, mechanical resistance, low allergy-causing potential, effective cost, opportunity for clinical repairs, increase the use of composite veneers in clinical practice as a contemporary aesthetic solution[3].

Therefore, it is necessary to clarify and define the type of preparation which will give better performance of fixed-prosthetic works. The ideal scenario is to keep the bond completely in enamel. Labial and proximal surfaces should be uniform prepared, if possible, and no less than 0.3 mm to 0.5 mm[4]. The preparation's margins must be chamfered and in enamel[5]. Regarding the reduction of the incisal edge, preparation design can be classified as: *window preparation* (non reduced incisal edge); *feather preparation* (non reduced incisal edge with the entire labial surface covered by the veneer); *bevel preparation* (reduced incisal edge with bucco-palatal tilt preparation over the entire tooth width); *incisal overlap or palatal chamfer* (the reduction of incisal edge with palatal extension preparation). An important decision that should be made before starting the preparation is whether the incisal edge will be reduced or not.

Indirect technique is used to fabricate a restoration in a dental laboratory. The composite veneers are bonded to the teeth by adhesive luting techniques and restore mechanical and biological function with minimally

invasive procedures. According to Fahl[6] this type of materials when subjected to heat and in combination with increased exposure to visible-spectrum light, pressure or vacuum, present greater conversion of the resin through increased polymerization. Thereby, this conversion results in altered physical properties of the material, like hardness, mechanical resistance, color stability and biocompatibility[7].

The aim of this *in vitro* study was to examine the fracture load of composite veneers using three different preparation designs.

Methods and materials

Fifteen extracted, intact, human maxillary central incisors with similar dimensions were selected for this study. Teeth were inspected for defects or cracks, and external debris or calculus was removed by ultrasonic scaling. Selected teeth were stored in Normal saline solution (Nirma Ltd, Gujarat, India) at room temperature throughout the study.

Teeth were randomly divided into three groups (n=5) with different preparation design: 1) feather preparation, 2) bevel preparation, and 3) incisal overlap-palatal chamfer.

Impressions of the prepared cavities were taken with heavy body and light body impression material Express XT Regular Body and Express XT Putty Soft (3M ESPE Dental Products, Seefeld, Germany) and working models were fabricated. Restorations of the cavities were performed with a composite material (SR Adoro, IvoclarVivadent, Schaan, Liechtenstein) according to the manufacturer's instructions. The material was polymerized in a curing unit (Lumamat 100, IvoclarVivadent) and veneers were bonded to the teeth using a resin cement (Variolink Esthetic, IvoclarVivadent).

Subsequently, specimens were loaded to the failure (cyclic/stress path triaxial system) in a testing machine (TRITECH WF 10056, Wykeham Farrance, Milan, Italy).

The fracture strength test was performed at a constant speed of 0.5 mm/min. The force was applied at a 45˚ angle to the long axis of the tooth. Fatigue failure for each specimen was recorded and the data were statistically analyzed. The mode of failure was determined as debonding or fracture and subjected to microscopy visualization (Olympus microscope SZ2-ILST model, Figure 1). The localization of the fracture was classified as incisal, gingival or combined. The data were statistically analyzed using statistic package – SPSS version 23.

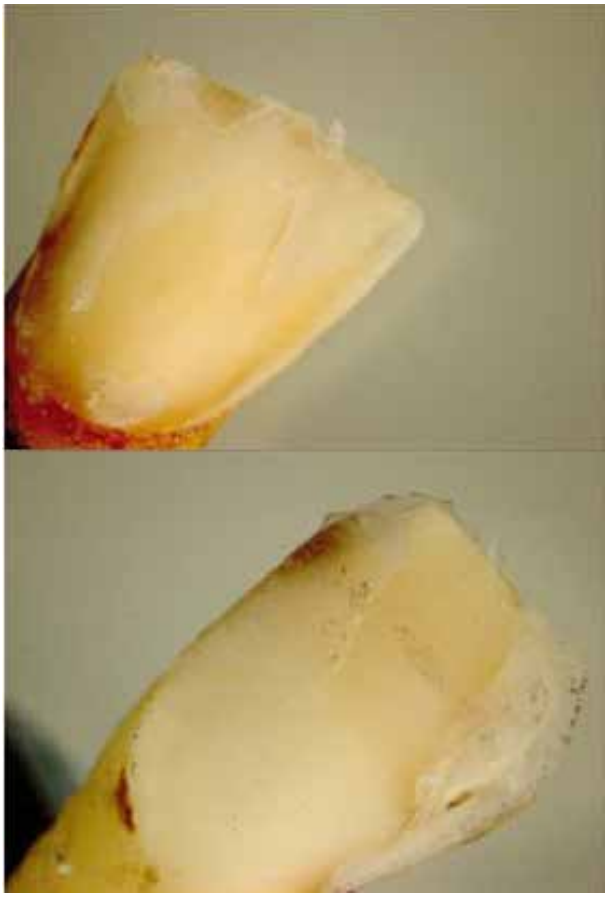

Figure 1.The visualization of the fracture.

Results

Regarding the maximum load, composite veneers with incisal overlap-palatal chamfer showed higher fracture resistance (122.0±8.8 N) compared to feather preparation (107.4±6.8 N) and bevel preparation (100.6±8.0 N). T-test for means showed a statistically significant difference in the fracture resistance was found among the three preparation designs ($p<0.05$). Regarding the type of failure, debonding of composite veneers was characteristic for feather preparation (80%), while fracture predominately occurred in the bevel preparation (80%) and incisal overlap (80%) groups. The most common localization of fractures was incisal (Table 1).

Discussion

Due to the actuality and more frequent use of veneers in everyday clinical practice, it is necessary to clearly define the type of preparation that will achieve better aesthetic and mechanical properties of fixed-prosthetic restorations.

Table 1. Fracture load, mode of failure and localization of fracture of composite veneers fabricated with different preparation design

	Feather preparation			Bevel preparation			Incisal overlap		
n	Fracture Load (N):	Mode of failure	Localization of fracture	Fracture Load (N):	Mode of failure:	Localization of fracture	Fracture Load (N):	Mode of failure:	Localization of fracture
1	99	Debonding	/	99	Fracture	incisal	129	Fracture	incisal
2	112	Debonding	/	116	Fracture	incisal	133	Fracture	incisal
3	99	Debonding	/	112	Fracture	incisal	116	Debonding	/
4	90	Debonding	/	103	Fracture	gingival	120	Fracture	combination
5	103	Fracture	gingival	107	Debonding	/	112	Fracture	combination
Mean	100.6			107.4			122		
Std.dev	7.956			6.804			8.803		
Std.error	3.567			3.051			3.947		

In the present study we employed *in vitro* testing which enables fast and effective analysis. In addition, experimental studies eliminate subjective factors such as: strength of chewing pressure, mastication and the food type. However, it is quite difficult to reproduce conditions analogue to those in the mouth. At the same time, in the literature there is not enough data for the examination standards and methodology of the fracture resistance of porcelain veneers. It is assumed that this is because of the complex geometric shape of the veneers.

Human teeth were used in this study because they have unique properties, such as strength, elasticity, bonding characteristics and enamel thickness that influence the results of *in vitro* examination[8,9]. On the other side, using human teeth has the limitations, because these are difficult to standardize based on size and age. Therefore, the teeth which had major differences in size were excluded from our sample. Mechanical characteristics are of great importance for successful restoration with veneers. There are many ambiguities and controversies regarding the veneers preparation designs in the literature. Most of the studies which analyzed porcelain veneers presented that the material used in fabrication of veneers had an influence only on the fracture load value and not on the preparation design[10].

In our study we have used laboratory processed composite resin which is a micro-filled, light/heat cure composite. It is suitable for fabrication of both metal supported and metal free restorations such as inlays, onlays and veneers. This system offers few advantages over hybrid composite materials, like handling, plaque and mechanical resistance and surface finish. This is because of high proportion of inorganic fillers in the nanoscale range. Moreover, the matrix is based on a urethane dimethacrylate (UDMA) that is recognized for its toughness, which is higher than that of its predecessors or the frequently used BisGMA[11,12].

It is critical for the dentist to understand that the preparation design has big influence on the survival rate and therapy success[13]. Meijering[14] described that there were no differences in the survival rates and mechanical resistance of veneers whether the incisal edge was reduced or not. Similar results were obtained in *in vitro* study conducted by Alghazzavi[10] et al. The values they received show that there was no statistical difference in fracture strength of the veneer depending of preparation design.

Opposite results, with statistically significant differences in values between different types of preparation were achieved in *in vitro* study by Mirra[15]. The highest value for fracture resistance was described in veneers with bevel preparation, while veneers with incisal overlap-palatal chamfer preparation design showed lowest fracture strength.

Most of the authors recommend preparation design where incisal edge is reduced[16,17,18]. Considering the delicate and fragile nature of the restorations, some of the authors describe that veneers made with incisal overlap (palatal chamfer) preparation type have the best tolerance of stress distribution[13,19,20,21,22]. The results we gain in this study correspond also to the findings made by Schmidt et al.[23], Chaiyabutret al.[24] and Akogluand Gemalmaz[25]. They separately examined fracture resistance of ceramic veneers with different preparation designs and the higher value for fracture strength was confirmed for veneers with incisal overlap – palatal chamfer design.

In the present study, a statistically significant difference in the fracture resistance among the three preparation designs was found, with incisal overlap–palatal chamfer showing the highest fracture resistance this can be explained by an increased tooth surface

available for bonding. It is very important to provide enough space and minimum thickness of the composite cement in order to reduce the stress applied to the facets[26], and the incisal overlap– palatal chamfer design provides a definite seat for cementation.

Lower fracture resistance in the bevel preparation and feather preparation groups can be explained by thin incisal edges of the prepared teeth which do not provide a definite path of placement while cementation of the veneer. Our study also confirms previous findings that fracture of the veneers usually appears on the incisal edge of restoration due to the presence of larger stress[27].

Fracture resistance also depends a lot from the direction of the applied force. Maxillary veneers during mastication and protrusion have interincisal angle of 135 degrees and it is not parallel to the longitudinal axis of the tooth[28]. Both, the functional and parafunctional forces applied to the palatal surface move the veneer facial. Clinical studies[29] have confirmed that veneers bonded to mandibular incisors are less susceptible to fractures, due to less destructive nature of the forces of pressure that occurs on the incisal edges[30]. Most of clinical fractures occur to veneers cemented to maxillary incisors[22].

Conclusion

Within the limitations of the present study, it can be concluded that the type of preparation has a significant effect on fracture load for composite veneers. Incisal overlap– palatal chamfer preparation design significantly increases the fracture resistance compared to feather and bevel preparation designs.

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Examination of Natural Tooth Color Distribution Using Visual and Instrumental Shade Selection Methods

SUMMARY

Aim: *Although visual color determination is the most frequently applied method in dentistry, instrumental color analysis offers advantages like objectivity, measurability and rapidity. The aim of this study was to evaluate the natural teeth color in teeth without any restoration visually, and by using a computerized shade measuring and analyzing system in the population.*

Materials and Methods: *202 patients were inspected. Before instrumental shade matching visual matching was done by the inspector with Vitapan 3D Master Shade Guide in the day light. Images were taken with computerized shade measuring and analyzing system from patients' natural right or left maxillary incisors and canines without any restoration. Then these images were evaluated by the original software of its own.*

Results: *Value differences between visual and instrumental shade matching were statistically significant. Darker value levels were obtained with instrumental measurement. The distribution of hue was more reddish in instrumental examination than visual examination. Significant difference was found at cervical and middle third of the tooth in both visual and instrumental determination of chroma. Chroma of the tooth was higher at these two regions in visual assessment.*

Conclusions: *Teeth colors were distributed more uniform in visual shade matching compared to instrumental matching. However, some teeth shades were more common in instrumental matching. Value scores were found higher with instrumental shade matching. Individual selection of shades for each tooth and different regions of a tooth instead of a single color is considered to be a factor to increase the success of the restoration.*

Key-words: Tooth color, visual, instrumental, shade selection

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Introduction

The esthetics of a restoration depends on shape, surface form, translucency, and color. Color assessment and reproduction remains one of the most challenging aspects of the esthetic dentistry; however, matching of a restoration to existing tooth enamel is not predictable[1].

In recent years, investigators have attempted to utilize color science and color theory to devise a standard that will allow expression of colors numerically; in much the same way length and weight are expressed, for easier and a more precise transfer and communication of color in restorative dentistry[2].

When the color is measured by a visual technique, the considered color is compared with a large set of color tabs[3]. Dental shade guides are commonly used to evaluate tooth color in restorative procedures. A shade guide is composed of a set of shade tabs intended to cover the range of colors present in the human dentition. The successful achievement of a clinically acceptable color match between a given tooth and a shade tab is closely related to the spectral coverage of the shade guide, clinician's experience and the viewing environment[2,4]. Color can be described according to the Munsell color

space in terms of hue, value and chroma. Value is determined firstly, followed by chroma that is determined close to the measured value but of increasing saturation of color. Hue is determined last by matching with the color tabs of the already determined value and chroma[3].

Numerous reports have indicated that common shade guides do not provide sufficient spectral coverage of the colors present in the teeth. Moreover, tab colors may not be distributed uniformly throughout the color space of natural teeth, leading to close matches for some shades and gross mismatches for others. The underlying assumption for shade guides is that the difference between the true color and the closest shade tab would not be discernible by the human eye[4].

As a means of extending the effectiveness of the existing guides, Sproull suggested, among other things, that porcelain stain kits include 5 value choices? . Five value choices are the starting point for the Vitapan 3-D Master Shade Guide. In 1980, Preston and Bergen published a workbook that identified value as the most important determinant of color[5]. The Vita 3D-Master shade guide features a systematic colorimetric distribution of 26 shade tabs within the tooth color space. The manufacturer reports that this shade guide demonstrates an equidistant distribution in the color space. Vitapan 3D Master represents improvement compared to Vitapan Classical and covers greater natural teeth color range[6]. The color distribution of the Vitapan 3D Master shade guide is more ordered than traditional shade guides[7]. Vitapan 3D Master shade guide also has an improved repeatability when compared to other shade guides[8,9]. The shade guide is organized into 5 primary value levels, with a secondary distribution based on chroma and hue. The first number represents the value, the letter is the hue and the last number is the chroma. Value groups are arranged from lightest (value level 1) to darkest (value level 5), left to right[10]. There are 3 chroma levels, from 1 (the least chromatic) to 3 (the most chromatic) in each group (except in group 1 that has two chroma levels). Intermediate chroma levels (1.5 and 2.5) in groups 2, 3, and 4 are associated with hue variations - L (more yellow) and R (more red)[11].

The spectrophotometric/colorimetric approach is attractive because it allows an objective assessment of tooth color, independent of viewing conditions and examiner experience[2,4]. Currently there are several electronic shade-matching instruments available for clinical use. These devices can be classified as spectrophotometers, colorimeters, digital color analyzers, or combinations of these[12].

The first system to combine digital color imaging with colorimetric analysis was introduced by Cynovad (Saint-Laurent, Canada). The ShadeScan is a hand-held device with a color LCD screen to aid in image location and focus. Through a fiber optic cable, a halogen light source illuminates the tooth surface at a 45° angle and collects the reflected light at 0°. Light intensity and calibration to gray and color standards are continuously monitored and adjusted to provide consistent color reproduction. The image is recorded on a flash card, obviating the need for a computer. The transmitted data can be downloaded to a computer with the ShadeScan software. Shade and translucency mapping can therefore be transmitted to the dental laboratory by e-mail or by including a printout or flashcard with the clinical items required for restoration fabrication. Surface shade mapping with the standard software is in basic Vita Lumin shade designations. Higher-resolution shade mapping, additional shade guide designation conversions, and Hue/Value/Chroma values are optional with additional software for dental laboratories[12-15].

Some studies have compared the electronic devices by visual observation[16-27] or evaluated two or more electronic devices[1,12,28]. Other studies have evaluated color and translucency in relation to the physical properties of porcelains and the color reproduction of porcelains[1]. However, only a few studies have evaluated the tooth color distribution in population.

The aims of this study were to (1) analyze shade distributions, (2) investigate chroma, value and hue differences within maxillary anterior teeth, and differences of value for each site of teeth with visual and instrumental shade matching.

Materials and Methods

Study population

Subjects (n=202, 85 women and 117 men, average age 34.4) were recruited from the dental students and the patients appealed to the Clinics of Gazi University, Faculty of Dentistry, Ankara, Turkey. Informed consent was obtained from all participants included in the study under a protocol reviewed and approved by the ethics committee of Gazi University Faculty of Medicine (No: 209 as of 12th September 2005). The experimental unit of this study were the right or left maxillary central and lateral incisors and canines. To be included in the study, subjects had to present with least one permanent maxillary central and lateral incisors and canine free of caries and restoration and with a reasonable alignment within the arch to facilitate shade measurement. Subjects were excluded if they had tooth discoloration as a result of congenital diseases or side effects of medications, and if they had had tooth bleaching or non-vital teeth.

Visual shade matching

Visual shade matching was done by a research assistant in the Department of Prosthodontics who has not any color perception deficiencies.

For shade matching subjects were upright with the mouth at the observer's eye level. External visual influences, such as lipstick were removed. Upper and lower teeth were apart and the tongue retracted. The shade tab

was positioned in the same plane as the tooth to be matched by the observer. Shades were selected from slightly moistened teeth in the day light. The Vita 3D Master shade guide was used as the basis for this study because of its wide distribution and the observer's familiarity with it. The examiner determined the color shades with no time limits for each tooth third (cervical, middle, incisal) using Vitapan 3D Master shade guide (Vita Zahnfabrik, H. Rauter Gmbh&Co. KG, Bad Säckingen, Germany) that was regularly ordered into the five value groups – 1, 2, 3, 4 and 5. Shades were determined for each tooth in its cervical, middle and incisal third, according to the manufacturer's recommendations in the following order: value, then chroma and finally hue.

Instrumental shade measurement

Following visual shade matching, computer aided shade measurements were done (ShadeScan, Cynovad, Montréal, Canada) by the same observer. At the beginning of each session, the instrument allowed to warm up according to manufacturer's instructions. The subjects were instructed to lean their heads against the headrest of the treatment chair during the measurement and to keep their mouth slightly opened. The tongue had to be in a relaxed position since pressing of the tongue against the maxillary front might cause mismeasurements by tissue shining through due to incisal translucency of the tooth. The surgical lamp of the treatment unit remained turned off during measurements.

ShadeScan was calibrated automatically on the docking station prior to measurements. After the handset was taken from the docking station, the instrument was positioned so that the required tooth was in the middle of the highlighted rectangular border shown on the colored liquid crystal display screen. The measuring head was placed on the surface of the teeth as perpendicularly as possible, beginning with the central incisors. At the end of the measurements, the data were transmitted to the computer. The tooth area from which the shade was to be taken was determined using the software of its own, and the output was recorded. Shades were determined for each tooth in its cervical, middle and incisal third.

Statistical analysis

We used a statistical program software, SPSS version 13 for Windows (SPSS Inc., Chicago, IL, USA), to perform the analysis. We used Wilcoxon Signed Ranks Test to compare the data. We considered a p value < 0.05 to be significant.

Results

This study involved a total of 202 subjects who ranged from 17 to 85 years of age (average age 34.4), and 606 teeth were investigated. Color distribution data of visual and instrumental shade matching is given in figure 1.

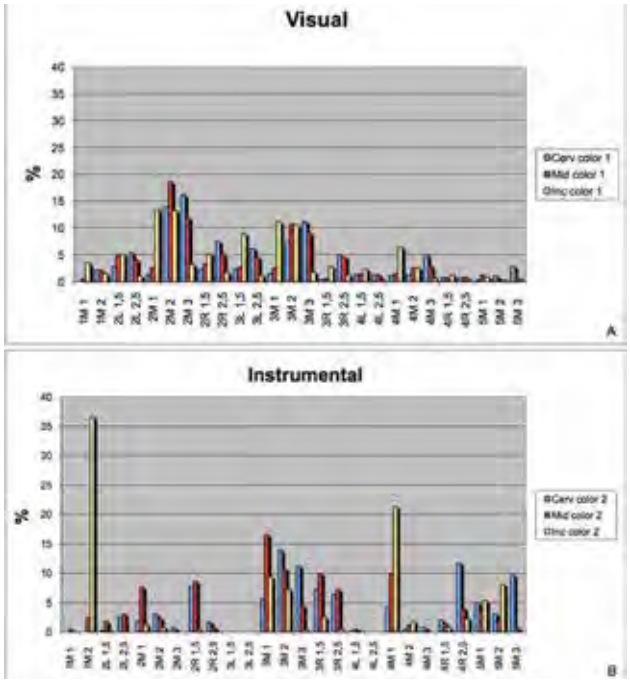

Figure 1: A) Visual shade selection, B) instrumental shade selection

All the tabs in the shade guide were determined at three sites of teeth in visual shade matching but mostly between 2M1 and 3M3 region.

There was not any 1M1 and 1M2 matching at cervical site of teeth in instrumental measurement, and 1M2 was the most common tooth color at incisal site. In our study 3L1.5, 3L2.5, 4L2.5 were not determined at any region of teeth by instrumental measurement.

Value level differences between visual and instrumental shade matching were statistically significant at all sites of teeth (cervical and middle third p=0.0001, Wilcoxon Signed Ranks Test). Darker value levels were obtained with instrumental measurement. At cervical region, level 2 was most common (49.2%) in visual matching, while level 3 was most common (44.4%) in instrumental matching. All results are given in table 1 for different sites of teeth.

In the assessment of the hue, it was observed that the distribution of hue was more reddish in instrumental examination than the visual examination of the teeth color (p = 0.0001, Wilcoxon Signed Ranks Test). M showed higher rates at all three regions of the teeth when L, M and R distributions were examined both instrumentally and visually. In instrument measures, incisal region was found to be 92.6% of the M tone seen. Hue L was seen 19% at cervical region, 18.3% at middle third and 18.6% at incisal respecting visual examination. Ratios obtained from instrumental measurements were 3.1%, 5.4%, 0.5% respectively. The incidence of hue R at cervical and middle third of the teeth was twice higher in instrumental examinations than the examinations made visually. Contrary, data obtained from visual measurements was twice the ratios obtained from the instrumental measurements at the incisal region (Tab. 1).

Table 1: Results of value, hue and chroma analysis of maxillary anterior teeth

			n	Mean Rank	Z	p
COLOR	Cerv Color [2]-Cerv Color [1]	Negative Ranks	77[a]	131,51	-17,173*	0,0001
		Positive Ranks	456[b]	289,88		
		Ties	73[c]			
		Total	606			
	Mid Color [2]- Mid Color [1]	Negative Ranks	157[d]	191,47	-11,864*	0,0001
		Positive Ranks	383[e]	302,89		
		Ties	66[f]			
		Total	606			
	Inc Color [2]- Inc Color [1]	Negative Ranks	235[g]	246,06	-6,161*	0,0001
		Positive Ranks	338[h]	315,46		
		Ties	33[i]			
		Total	606			
VALUE	Cerv Value [2]- Cerv Value [1]	Negative Ranks	32[a]	146,00	-15,779*	0,0001
		Positive Ranks	354[b]	197,79		
		Ties	220[c]			
		Total	606			
	Mid Value [2]- Mid Value [1]	Negative Ranks	69[d]	155,46	-10,896*	0,0001
		Positive Ranks	270[e]	173,71		
		Ties	267[f]			
		Total	606			
	Inc Value [2]- Inc Value [1]	Negative Ranks	215[g]	246,02	-2,618*	0,009
		Positive Ranks	278[h]	247,76		
		Ties	113[i]			
		Total	606			
HUE	Cerv Hue [2]- Cerv Hue [1]	Negative Ranks	67[a]	141,03	-10,316*	0,0001
		Positive Ranks	247[b]	161,97		
		Ties	292[c]			
		Total	606			
	Mid Hue [2] - Mid Hue [1]	Negative Ranks	83[d]	145,85	-8,531*	0,0001
		Positive Ranks	231[e]	161,69		
		Ties	292[f]			
		Total	606			
	Inc Hue [2]- Inc Hue [1]	Negative Ranks	71[g]	103,00	-5,049*	0,0001
		Positive Ranks	141[h]	108,26		
		Ties	394[i]			
		Total	606			
CHROMA	Cerv Chroma [2] - Cerv Chroma [1]	Negative Ranks	298[a]	212,37	-10,047**	0,0001
		Positive Ranks	104[b]	170,37		
		Ties	204[c]			
		Total	606			
	Mid Chroma [2] - Mid Chroma [1]	Negative Ranks	403[d]	237,37	-15,757**	0,0001
		Positive Ranks	53[e]	161,07		
		Ties	150[f]			
		Total	606			
	Inc Chroma [2] - Inc Chroma [1]	Negative Ranks	214[g]	257,13	-,910*	0,363
		Positive Ranks	266[h]	227,12		
		Ties	126[i]			
		Total	606			

[1] Visual shade selection; [2] Instrumental shade selection

[a] Cerv [2] < Cerv [1]; [b]Cerv [2] > Cerv [1] ; [c] Cerv [2] = Cerv [1]; [d] Mid [2] < Mid [1] ; [e] Mid [2] > Mid [1] ; [f] Mid [2] = Mid [1]; [g] Inc [2] < Inc [1] ; [h] Inc [2] > Inc [1] ; [i] Inc [2] = Inc [1]

* Based on negative ranks.

** Wilcoxon Signed Ranks Test

p<0,05

Statistically significant difference was found at cervical and middle third of the tooth in both visual and instrumental determination of the chroma. Chroma of the tooth were found higher at these two regions in visual assessment ($p = 0.0001$, Wilcoxon Signed Ranks Test). Chroma degree, defined with number 3, was detected more common at the cervical part of the teeth in both assessment methods (35% visual and 22.6% instrumental). The most common chroma degree was number 2, respecting visual assessment with 34.2% rate, and number 1.5 respecting instrumental assessment with 22.3% rate at the middle third of the teeth. At the incisal region, No. 1 chroma degree with 35.5% in the visual assessment and No. 2 chroma degree with 54.6% in the instrumental assessment were the most common degrees (Tab. 1).

Discussion

In this study, both visual and instrumental shade selection methods are used together. ShadeScan, which combines digital images with a computer program, was selected as the device to be used. Having an extensive clinical usage, Vitapan 3D Master was utilized as the shade guide.

Spectrophotometers' widespread use in clinical settings and dental research has been hindered by the fact that the equipment was complex, expensive and it was difficult to measure the color of teeth *in vivo* with these machines[23,29,30]. Some of the *in vitro* and *in vivo* dental researches on the color of natural teeth and porcelains, have been conducted with colorimeters[1,14,16,19,29]. Colorimeter measurements have been compared with spectrophotometer readings and deemed reliable and accurate for color difference measurements. In general, colorimeters have shown good repeatability of natural tooth color measurements *in vitro* and *in vivo*[29-31].

The Vitapan 3D Master shade guide was the most suitable one in visual shade selection among the five shade guides that were compared. Clinical experience does have some effect in shade selection and consensus among observers significantly decreased color errors in Vitapan 3D Master and Vintage Halo NCC shade guides[19,32].

In 1998, Okubo et al[16] tested recognition of Vita Lumin shade tabs using another identical shade guide and, at that time, a new colorimeter. The colorimeter was successful in 50%, and the visual examiners in 48% of the cases. Tung et al[29] reported that when using Vita Lumin shade guide, experienced clinicians reached 55-64% agreement with a colorimeter. On the contrary, in their study the repeatability of colorimeter measurements was at the level of 82%. The clinicians showed 73% of agreement with each other. Based on their study Paul et al[17] reported only 27% reproducibility among three human observers who determined the shade for the maxillary central incisors of 30 subjects.

Dozic et al[1] indicated that there was no difference between performances of spectrophotometer and digital camera in shade matching under standard conditions. It was concluded that ShadeScan is the most accurate device in terms of repeatability when used for the same patient. Furthermore, ShadeScan, Ikam and Easyshade were found to be the most reliable devices *in vitro*[1]. For devices that detect tooth color from a small area, how accurately measurements can reflect the tooth color is a controversial issue[33]. ShadeScan, used in our study, seems to be advantageous since it presents tooth colors in different regions on the photo of the tooth as a map.

Hugo et al[18] reported that computer-aided color shade determination of natural teeth does not seem to reflect human perception. On the contrary, Paul et al[17] found that spectrophotometric color analysis (83%) was more accurate and repeatable when compared to visual shade selection (26.6%; $p<0.0001$). This research is similar to our study, since significant difference was observed between visual and instrumental measurements.

In a study conducted on extracted teeth by Analoi et al[4], 3 different shade guides were compared and Vitapan 3D Master was concluded to have the best shade content for extracted teeth. Because of the fact that the study was performed on extracted teeth, the results cannot provide accurate information about the shade guides' clinical performance. Shade difference between extracted and not extracted teeth is mainly based on the pulp content and blood circulation of the tooth besides of the population, age and nutrition.

The maxillary central incisor has frequently been used in evaluations of tooth color[10,17,21,29,32,34-37]. Since color differences have been recorded among different teeth of some patients[38], it appears that maxillary central incisors do not represent overall tooth color. Therefore, left or right maxillary central, lateral incisors and canines were chosen for this study, similar to previous studies[18,22]. The value, the amount of lightness or darkness of a color, is of a great importance to the restorative process; if the value is correct, the restoration can be successful even if the wrong hue and chroma have been selected[39].

The range of color and distribution of color in different regions of the tooth have been described by a number of investigators. It was indicated that there were statistically significant color differences between the regions, and these differences were also clinically significant[34,37,40].

In this study, shades of 606 natural teeth in 202 subjects (85 females, 117 males; mean age: 43.4 years) were examined. In visual shade selection, it is observed that the shades in the range of 2M-1 to 3M-3 were selected commonly and shade selections were distributed in the population uniformly. The most selected shades were; 2M-3 for cervical area (16.2%), 2M-2 for middle

third (18.6%) and 2M-1 for incisal area (13.5%). Shade distribution observed in instrumental examination was not homogeneous. In the cervical area of the tooth light shades in the guide like 1M-1 and 1M-2 were not selected. The most selected shade was 3M-2 (13.9%). The most selected shade in the middle third was 3M-1 (16.5%). The most selected shades in the incisal area were 1M-2 (36.6%) and 4M-1 (21.3%), respectively. In instrumental shade selection 3L-1.5; 3L-2.5 and 4L-2.5 were not detected in any area of the tooth.

In a study including *in vivo* color measurements of 2830 anterior teeth, measurements were made in cervical, middle and incisal sites of the coronal portions of the teeth by a colorimeter. The incisal mean hues were more yellow than those of the middle site. For value, the means were similar for all three sites although some higher values were found for some incisal sites. For chroma, the means for incisal and middle sites were almost identical but the cervical sites appeared more saturated similar to our results[38].

In terms of restorative procedure, the lightness and darkness of the teeth have a great importance. It is emphasized that if the value is correct, restoration can be successful even if wrong hue and chroma were selected[39].

Conclusion

Within the limitations of this study, the following conclusions were drawn:

In visual shade selection lower value was selected when compared to instrumental method;

Tooth color was not uniform and it was not composed of a single color;

Shades of the cervical regions were darker and had higher chroma.

Based on the results obtained, individual selection of shades for each tooth and different regions of a tooth instead of a single color is considered to be a factor to increase the success of the restoration.

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Generalized Severe Periodontitis and Periodontal Abscess in Type 2 Diabetes: A Case Report

SUMMARY

The bidirectional relationship between periodontitis and diabetes mellitus can cause distinct oral symptoms that can impact the general health conditions of affected patients. The presented case report of a female diabetes type 2 patient with severe periodontitis and a periodontal abscess shows how interdisciplinary collaboration between the attending physician and dentist can significantly improve oral conditions and metabolic control.

Key words: diabetes type 2, oral symptoms, periodontitis

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CASE REPORT (CR)
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Introduction

Diabetes mellitus is a group of metabolic diseases that are characterized by chronic hyperglycaemia resulting from defects in insulin secretion, insulin action, or both[1]. The majority of diagnosed cases of diabetes can be differentiated into 2 main etiopathogenetic categories: type 1 diabetes mellitus and type 2 diabetes mellitus[1]. Type 1 diabetes mellitus (also known as juvenile diabetes or insulin dependent diabetes mellitus) is caused by an absolute deficiency of insulin secretion, mostly resulting from auto-immune destruction of the pancreatic β-cells. Approximately 5-10% of diabetes patients are related to this category[1]. More prevalent is type 2 diabetes mellitus (90-95% of diabetes patients). Type 2 diabetes mellitus (also known as adult-onset diabetes or non-insulin-dependent diabetes mellitus) is often caused by a combination of resistance to insulin action and an inadequate compensatory insulin secretory response, leading to a relative deficiency of insulin secretion[1]. The risk of developing type 2 diabetes mellitus increases with age, weight and lack of physical activity. Chronic hyperglycaemia in diabetes patients is associated with a wide range of secondary diseases, including retinopathies, nephropathies, peripheral neuropathies and cardiovascular diseases[1].

Periodontal disease is a destructive inflammation of the tooth supporting tissues resulting from a complex multi-factorial disorder, which involves various microorganisms organized in a dental plaque biofilm and interactions of host cells. Furthermore, genetic predispositions[2], systemic diseases such as diabetes mellitus[3], and personal behaviour such as smoking[4] and oral hygiene[5,6] play an important role in the etiopathogenesis of periodontitis, which may lead to loss of attachment, destruction of alveolar bone, and to periodontal pocket formation, ultimately causing tooth loss.

Diabetes mellitus and periodontal disease are both multifactorial diseases with a high prevalence worldwide. The International Diabetes federation estimates that from 2011 to 2033 the global number of people with diabetes mellitus will grow from 366 million to 552 people[7]. Numerous cross-sectional and longitudinal prospective clinical studies provide evidence for a bidirectional relationship between both diseases and intense efforts have been devoted to elucidate the underlying mechanisms[3,8]. Recent evidence indicates that diabetes mellitus promotes the occurrence, the progression and the severity of periodontitis, whereby the glycaemic control of the patients seems to be the strongest influencing factor. *Vice versa*, periodontal inflammation complicates the glycaemic control of diabetes and seems to have an impact on the risk and onset of diabetes associated complications. The presented case shows how interdisciplinary collaboration between attending physician and dentist can significantly improve oral conditions and metabolic control.

Case Report

A 50-year-old female patient was referred from her dentist to university hospital complaining of pain in the left maxilla and the right mandibular region. The patient reported that tooth #36 was extracted by her dentist 2 month ago because of swelling and strong pain. Furthermore, she reported about a stroke 1 year ago and a myocardial infarction 3 years ago. She was smoker (10 cig/d for 30 years, 30 pack years) and suffered from fibromyalgia, polyneuropathy, cardiac arrhythmia, hypertension, obesity (body-mass-index of 39) and diabetes mellitus type 2 (HbA1c of 7.7%). The diabetes was diagnosed 4 years ago and controlled with insulin (Insuman Comb 25® 24-0-24; Humalog® according to acquirements) and oral anti-diabetic medication (Metformin 1000mg 1-0-1). In addition, the patient took a plenty of other medications for her other diseases (Aggrenox, Ramipril, Torasemid, Bisoprolol, Pantoprazol, Amineurin, Simvastatin, Novalgin, Gabapentin, Amlodipin) and an allergy against penicillin was known.

Intraoral examination revealed dental plaque on all teeth (plaque control record- PCR- was 100%). The gingiva showed generalized signs of inflammation and in region #24 to #27 there was a swelling and suppuration with a fistula in the buccal region of #24. A mild gingival overgrowth in the mandibular and maxillary front area was observed. The patient had lost several teeth and had no prosthodontic treatment. Teeth #24 to #27 were flared out because of missing antagonists (Fig. 1). Caries was diagnosed on following teeth: #45, #46, and #36. All teeth, except #46, were vital. Periodontal probing depth (PPD) $\geq$ 4 mm was measured on all teeth. Teeth #16 to #23 and #24 to #27 showed a PPD $\geq$ 6 mm. Furcation involvements were diagnosed on teeth #16, #26, #27 and #46. Tooth 46 had a mobility degree of III. Bleeding on probing (BOP) was diagnosed in 24% of all sites examined (Fig. 2). Radiographic examination revealed generalized horizontal bone loss up to the middle of the dental roots, calculus and localized severe vertical bone loss. Tooth 46 showed a periapical and intra-radicular radiolucency and in region #36 the X-ray revealed a fresh extraction socket (Fig. 3).

Figure 1. Clinical conditions before systematic periodontal treatment

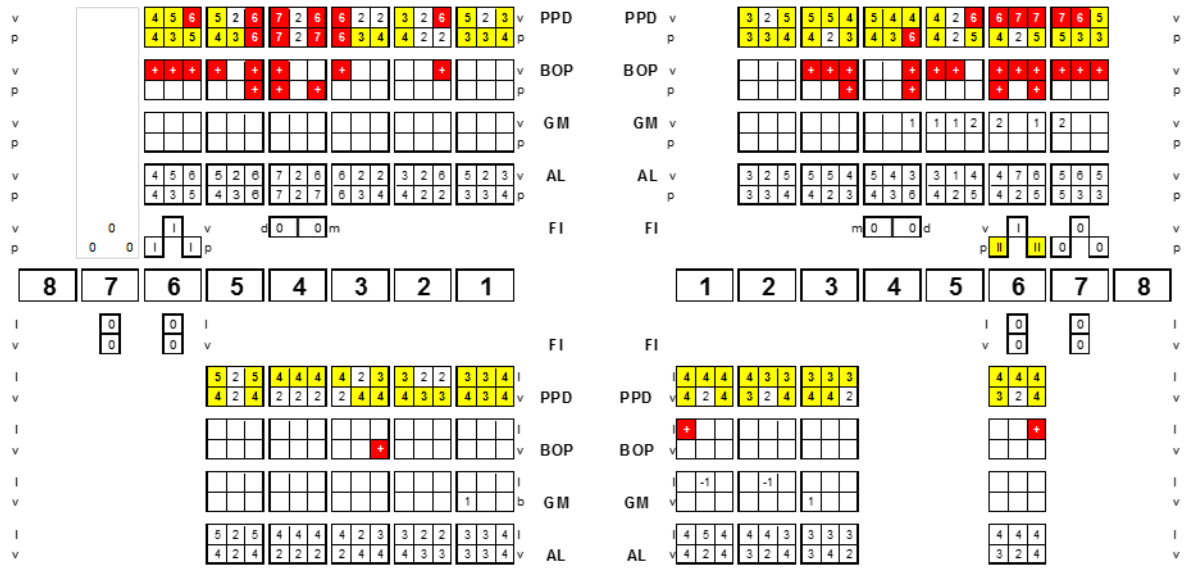

Figure 2. Periodontal status before systematic periodontal therapy. PPD: periodontal probing depth. BOP: bleeding on probing. GM: gingival margin. AL: attachment level

Figure 3. Panoramic radiograph of the patient

Following diagnoses[9] were made: 1. severe generalized chronic periodontitis modified by diabetes mellitus type 2; 2. periodontal abscess region #24 to #27; 3. gingival overgrowth associated with amlodipine; 4. tooth #46- profound caries and symptomatic apical periodontitis. Prognosis[10] of tooth #46 was set to be hopeless, while prognosis of teeth #24, #25, #26, and #27 was set to be unfavourable. Prognosis of all other teeth was expected to be favourable.

A collaborative dental-medical treatment plan was devised together with the attending physician. First of all, the abscess was drained and tooth #46 was extracted. An interim prosthesis was fabricated and inserted. The patient revealed oral hygiene training and professional tooth cleaning, as well as restorative therapy of the carious lesions (3 appointments within 7 weeks). Full-mouth disinfection (FMD) was performed under adjuvant antibiotic therapy in agreement with the attending physician (300 mg Clindasaar® 4 times per day for 7 days, beginning 1 day before FMD). Chlorhexidine 0.2% mouth rinse was prescribed for the following 2 weeks. Meanwhile, the attending physician reinstructed and motivated the patient again for diabetic therapy and optimized anti-diabetic medication (in addition: Victoza® 1,2 mg/ml 0-0-1). Re-evaluation of the periodontal status was performed 3 months after FMD. No signs of gingival inflammation and gingival overgrowth were observed in this visit. BOP was decreased to 2.4% of sites. All teeth showed PPD $\leq$ 4 mm without BOP except teeth #26 and #27 (5 and 6 mm). Subgingival scaling was repeated at teeth #26 and #27. Individual risk assessment[11] recommended supportive periodontal therapy (SPT) in a 3-month interval. The patient showed good compliance and missed no SPT appointment and no appointment with her physician. One year after FMD, periodontal examination showed no site with PPD > 4 mm and continuously low oral hygiene indices (PCR: 35%; GBI: 6%) as well as clinically healthy conditions (Figs. 4 and 5). Radiographic re-evaluation of the region #24 to #27 revealed osseous regeneration (Fig. 6). HbA1c-value dropped to 7.3%.

Figure 4. Clinical condition 1 year after full-mouth disinfection

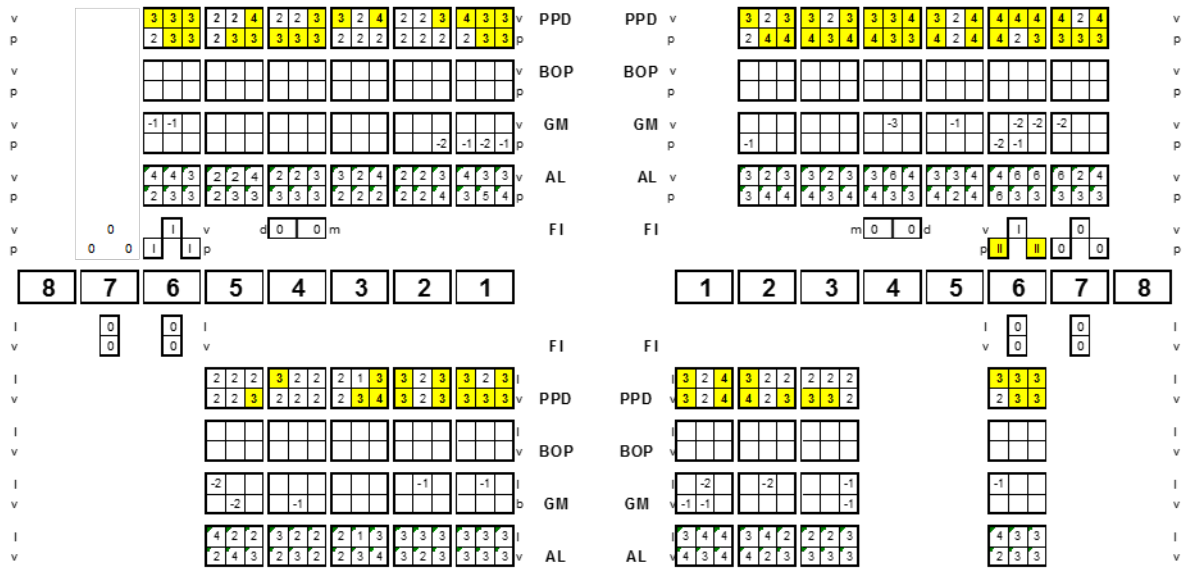

Figure 5. Periodontal status after 1 year of supportive periodontal therapy. PPD: periodontal probing depth. BOP: bleeding on probing. GM: gingival margin. AL: attachment level

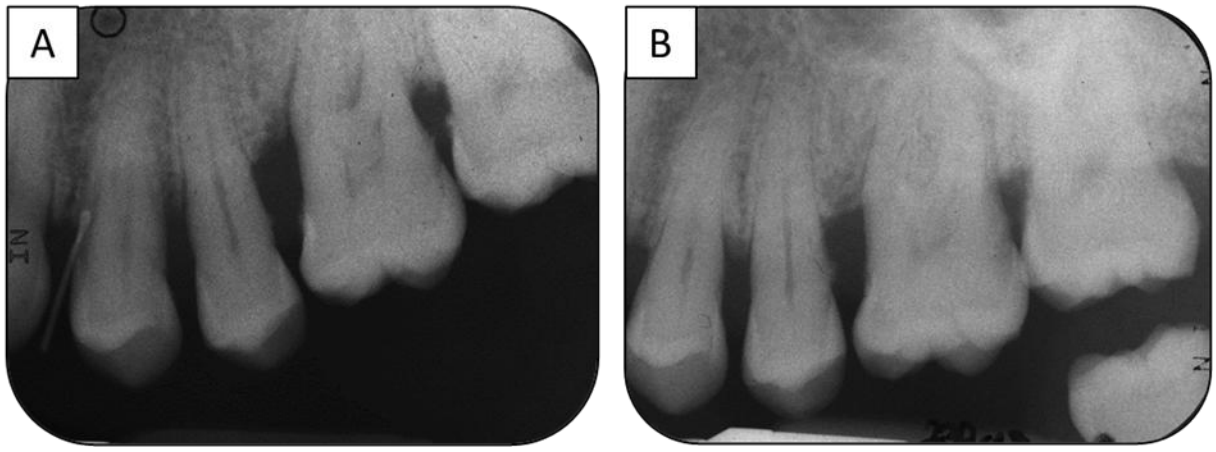

Figure 6. Radiography of region #24 to #26. A: Before periodontal therapy. Fistula tract region #24. B: 1 year after full mouth disinfection. Calculus at root surface #25 was removed afterwards

Discussion

The presented case report demonstrates the successful periodontal treatment of a female diabetes patient with a periodontal abscess, chronic periodontitis, and medical induced gingival overgrowth. Moreover, the patient's glycaemic control could be improved from HbA1c 7.7% to 7.3% after periodontal treatment and additional diabetic medication. The therapeutic results agree with recent evidence regarding response of diabetes patients to periodontal therapy.

Controlled studies have shown, that mechanical periodontal therapy of diabetes patients with periodontitis can improve HbA1c-value approximately 0.4%-points[8]. On the other hand, there is a consistent and robust evidence that severe periodontitis affects glycaemic control. Also, there is evidence for a direct dose-dependent relationship between severity of periodontal inflammation and diabetes complications, as well as growing evidence for an increased risk for diabetes onset in patients with severe periodontics[12]. The current understanding of biological mechanisms behind the bidirectional relationship is described as follows: type 2 diabetes is preceded by systemic inflammation, leading to insulin resistance and reduced pancreatic beta-cell function and apoptosis of these cells. Periodontal inflammation increases systemic inflammation by entrance of periodontal pathogens and their virulence factors into circulation[12]. Recent evidence suggests that local changes in the periodontal tissues are characterized by enhanced interactions between leukocytes and endothelial cells and by altered leukocyte functions (resulting in increased levels of reactive oxygen species and of pro-inflammatory cytokines- interleukin-1β, interleukin-6 and tumour necrosis factor-α). These local changes are amplified by the enhanced accumulation of advanced glycation end-products (AGEs) and their interaction with receptors for advanced glycation end-products (RAGEs). Furthermore, the increased levels of pro-inflammatory cytokines lead to an up-regulation of RANKL in periodontal tissues, stimulating further periodontal tissue breakdown. These complex changes resulting from diabetes conditions modify the local inflammatory reaction in the periodontium of diabetes patients, leading to a pro-inflammatory state in the gingival tissue and microcirculation[13]. In the presented case, the improvement of the HbA1c of 0.4%-points probably resulted from a combination of optimized medication and periodontal therapy. Dental interventions were planned in cooperation with the attending physician and treatment time was monitored closely and restricted between meals and medicine uptake, so that the patient was able to cope with her systemic challenge.

In addition to periodontitis, the patient also suffered from slight gingival enlargement induced by amlodipine. Recant evidence suggests that approximately 30% of patients with an intake of amlodipine develop gingival overgrowth[14]. Pathogenesis of calcium channel blocker induced gingival overgrowth remains unclear, but it is assumed that the secretory function of fibroblasts or collagenase synthesis is affected, resulting in the increased fibroblastic proliferation and collagen synthesis that may be enhanced by inflammatory changes within the gingival tissue[15]. Case series have shown that FMD is an adequate treatment concept for drug-induced gingival overgrowth reducing the need for further surgical interventions even in severe cases[16]. In the presented case, we diagnosed only a mild form of gingival overgrowth and adequate supra- and sub-gingival plaque control resulted in complete remission. It should be mentioned that the smoking habit of the patient also negatively influenced the periodontal status; however, all efforts to help the patient to quit smoking were not successful.

Conclusion

This case demonstrates that systematic periodontal treatment and better control of diabetes can result in remarkable improvements of periodontal and systemic conditions. To avoid risks that might interfere with treatment or its outcomes, the interdisciplinary coordination between dentist and attending physician plays a fundamental role in the treatment of periodontitis and diabetes.

Note: The results of this paper were presented as a part of an invited lecture at the 21st BaSS Congress.

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Aesthetic Closure Of Maxillary And Mandibular Anterior Spaces Using Direct Composite Resin Build-Ups: A Case Report

SUMMARY

The presence of multiple spaces in the anterior aesthetic zone can produce discomfort for patients and its treatment can be difficult for dental professionals. A variety of treatment options are available and these include orthodontic movement, prosthetic indirect restorations or direct composite resin build-ups. Among these, the closure of interdental spaces using composite build-ups combined with orthodontic treatment is considered to be most conservative. This type of treatment has several advantages like the maximum preservation of tooth substance (no tooth preparation), no need for anesthesia, no multiple time-consuming visits, no provisional restorations and also comparably low costs. Clinical Consideration: This case report describes the clinical restorative procedure of direct composite resin build-ups for the closure of multiple anterior spaces.

Key words: composite resin build-ups, multiple anterior spaces, aesthetic closure

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CASE REPORT (CR)

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Introduction

Tooth size discrepancy or inappropriate distribution of space in the anterior region is a major esthetic issue for patients of all ages[1]. The anterior spaces have a multifactorial etiology like microdontia, lateral incisor agenesis, habits like a finger sucking or tongue thrusting, lip sucking, dental–skeletal discrepancies and many more[2,3]. As dental patients are becoming increasingly conscious about their appearance, they demand for aesthetic and minimal invasive high quality restorations[4]. With the improvement of adhesive and composite technology it became possible that direct composite build-ups are able to withstand great masticatory forces without suffering from fracture or loss[5]. Recent aesthetic composite resin materials provide great optical properties and offer a wide range of shades and varying opacities, translucencies and textures[3].

However, the direct restoration technique may be difficult for the untrained dentist. Therefore, we present a case report showing the step-by-step fabrication technique of direct composite resin build-ups in the anterior dentition.

Case Report

A 35-year-old male patient visited the Department of Conservative Dentistry, Heidelberg University. He complained that large spaces between his maxillary and mandibular anterior teeth were present after orthodontic treatment (Figures 1a, 2, 4a, 5a). The patient´s medical history did not reveal any systemic diseases. Intraoral clinical examination revealed irregular spaces between the maxillary central incisors, lateral incisors and canines on both sides, as well as between the mandibular lateral incisors and canines on both sides. The largest interdental spaces were approximately 2 mm in width. The general tooth shade of A2 (incisal) and A3 (body) was satisfying, however the maxillary right central incisor needed internal bleaching due to discoloration after root canal treatment.

Patient’s periodontal health and occlusion were inspected, radiographs and inta- and extraoral photographs were taken. Diagnostic impressions, casts and a diagnostic wax-up were fabricated (Figure 7). The patient was found to be in good oral health (caries and restoration free) and no pathologies or interferences were found that would conflict with the treatment. The patient was

informed about the various treatment options (Veneers, crowns, composite resin build-ups). He preferred the most conservative approach favoring composite resin build-ups.

Figure 1a. Preoperative extraoral situation of patient with multiple spaces in anterior dentition.

Figure 1b. Postoperative extraoral situation of the patient after aesthetic closure of multiple anterior spaces with direct composit resin build-ups

Figure 2. Preoperative intraoral situation

Figure 3. Postoperative intraoral situation

Figure 4a. Preoperative intraoral situation

Figure 4b. Postoperative intraoral situation

Figure 5a. Preoperative intraoral view of the mandibular anterior spaces

Figure 5b. Postoperative intraoral view of the composite resin build-ups

After thorough dental consultation, the patient approved the treatment plan which included bleaching of the right maxillary central incisor and subsequent closure of the anterior spaces with direct composite resin build-ups.

The bleaching procedure followed an internal and external bleaching protocol, however it led to only minor brightening of the tooth color (Figure 6, 4a). Following, the composite resin build-ups were fabricated during one appointment. Initially, a palatal silicon mold made of putty material (Silaplast, Detax, Ettlingen, Germany) was created using the wax-up model (Figure 7). It is intended to assist when applying the first palatal layer of composite resin.

Figure 6. External bleaching of the left central maxillary incisor

Figure 7. Wax-up cast with silicon putty mold

Then, the tooth surfaces were cleaned with slurry of fine pumice. Enamel and dentin shades were determined to accurately match with the adjacent tooth structure. The patient's lips and cheeks were properly retracted (Optra Gate oral retractor, IvoclarVivadent, Schaan, Liechtenstein) and cotton rolls placed for the fluid control. The enamel was cleaned and roughened by airborne-particle abrasion with 27 µm aluminum oxide powder (Rondoflex, KaVo Biberach, Riss, Germany). The uncut enamel was then etched for 30 sec. with 37% phosphoric acid, rinsed for 20 sec. with air/water spray and lightly air-dried. A filled ethanol-based adhesive system (Optibond FL, Kerr, Orange CA, USA) was applied to the etched enamel and light-polymerized for 20 sec. (Bluephase C8, IvoclarVivadent, Schaan, Liechtenstein) (Figure 8).

Figure 8. Application of etching gel multi-step bonding system. Fabrication of the first palatal enamel layer with the silicon mold

A methacrylate-based nano-hybrid composite (Tetric Evo Ceram, IvoclarVivadent, Schaan, Liechtenstein) was used for the composite build-ups. It provides good handling properties and shade matching. A first thin layer of palatal/lingual enamel (Tetric Evo Ceram A3) was carefully shaped with transparent material using the silicone mold as a guide (Figure 8). This layer was then light cured for 15 sec. In order to avoid

a translucent shine-through-effect, a small amount of opaque dentin shade (Tetric Evo Ceram A3,5) was added on the proximal and incisal part, leaving space for subsequent characterization in this area. Therefore, a more translucent shade (Tetric Evo Ceram BleachM) was added characterizing the incisal edge. A single layer of a slightly darker shade of enamel (Tetric Evo Ceram A3) was applied onto the cervical-labial and cervical-proximal surfaces, whereas a lighter shade of enamel (Tetric Evo Ceram A2) was applied onto the incisal-labial and incisal-proximal surfaces. Each restoration was then fully light-polymerized for 60 sec. from multiple directions. Excess material was cut and removed with the aid of a size 12 scalpel and interproximal finishing was done with finishing strips. Further finishing was carried out with red diamond burs (for example 8889.314.009 Komet Dental, Gebr. Brasseler GmbH & Co. KG, Lemgo, Germany) and abrasive discs (Soflex, 3M Dental Products, St. Paul, Minnesota, USA) in order to create a surface macro- and microtexture. Final polishing was accomplished with silicone-impregnated polishing devices (Brownie/Greenie Shofu, Kioto, Japan) (Figure 9, 10). At this stage the incisal adjustment was also performed.

Figure 9. Preliminary results after the finishing procedure with red diamond burs and abrasive discs

Figure 10. Final polishing with silicone-impregnated polishing device

Discussion

In clinical cases where aesthetic corrections of anterior teeth are indicated the conservative direct composite resin technique may be preferable. However, to achieve the best aesthetic results, often an interdisciplinary approach is required[4]. In the presented case, minor orthodontic tooth movements were necessary before the teeth were corrected restoratively.

For the achievement of good results with a high level of predictability of treatment outcome, several aspects should be considered. Importantly, adequate diagnosis and planning should precede any treatment. In the presented case the treatment alternatives were either to insert indirect veneers or crowns, or to fabricate direct composite resin build-ups. This patient wished for a noninvasive treatment which led to the mutual decision on direct composite resin build-ups. To account for the advantages of this approach one can specify that the restorations can be placed in a single visit, provisional restorations are not necessary, the treatment is not painful therefore no anesthesia is required, the restorations can be easily repaired in case of failure, discoloration, fracture or chipping[7], and the composite resin material is not as hard as ceramics, therefore preserving the opposing teeth from un-physiological wear. The satisfactory aesthetical outcome is demonstrated by clinical studiesand various case reports[8,9]. There are also some disadvantages of direct composite resin build-ups which include that the material is prone to potential fracture when heavy parafunctional forces are present. Moreover, the surface texture, glaze and color stability are not as long-lasting as with glazed ceramics[10,11]. Like in all direct restoration techniques the outcome of direct composite resin build-ups is mainly influenced by the quality of the fabrication process (layering, finishing and polishing) giving high responsibility to the dentist.

Conclusion

Aesthetic insufficiencies like gaps and spaces in the maxillary and mandibular anterior dentition can be successfully treated with direct composite resin build-ups. The technique is least invasive when compared with treatment alternatives; it is reversible, repairable, and free of pain and can be carried out in one treatment session. Furthermore, depending on the insurance system of the respective country it represents, to a varying degree, a cost-effective method with interesting economic benefits for the patient and the dentist.

In most cases, this conservative approach results in complete patient satisfaction and successful long-term outcome.

Note: The results of this paper were presented as a part of an invited lecture at the 21st BaSS Congress.

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Preparation Junctions For All-Ceramic CAD/CAM Crown And Bridge Restorations

SUMMARY

Background: *The preparation junction type is determined by a number of factors that need to be taken in consideration with CAD/CAM Fixed Prosthodontics: the used material; the condition of the retainer teeth, their periodontium and the occlusion; the design software and the type of drills; the working protocol; the cement and the method of cementation.* ***The aim*** *of this article is to describe the optimal preparation junctions for CAD/CAM crown and bridge restorations made by ceramics based on zirconium dioxide and the basic factors that affect them.*

Materials and methods: *Chamfer and radial shoulder preparation junctions are suitable (width 1 - 1, 5 mm). Trimming of 1, 5–2 mm dental tissues is necessary on the occlusal surface. The homothetic tooth reduction is optimal. The surface has to be smooth and the edges rounded.*

Results: *The preparation width depends on the size and vitality of the tooth. In stained teeth the removal of more tissues provides a greater volume needed for masking the dark color. Vestibular preparation under the level of the gingiva is preferable to ensure optimal aesthetics. The preparation junction is determined also by the CAD/CAM software abilities, the type of drills and protocol of impression taking (classical or digital). The creation of a working model with an intraoral scanner is greatly facilitated by preparations above the gingival margin.*

Conclusions: *Knowledge about the criteria for selection of preparation junctions is essential for fabrication of accurate and aesthetic CAD/CAM restorations.*

Keywords: preparation junctions, CAD/CAM, all-ceramic crown and bridge restorations

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CASE REPORT (CR)
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Introduction

The type of preparation junction is determined by a number of factors that need to be aligned with CAD/CAM fixed restorations: the material of which the construction will be made[1]; the type and condition of the retainer teeth of their periodontium[2] and the occlusion[7]; the design software, the CAM setting and the type of drills[4]; the working protocol[5] – starting with a working cast poured of a classical impression (by laboratory scanning) or a digital model (made by intraoral scanning); the type of the cement and the method of cementation[6].

The aim of this article is to describe the optimal preparation junctions for CAD/CAM crown and bridge restorations made by ceramics based on zirconium dioxide and the basic factors that affect them.

Materials and methods

The suitable preparation junctions are chamfer (Figure 1) and radial shoulder (Figure 2) (width 1 - 1, 5 mm). Trimming of 1, 5 - 2 mm dental tissues is necessary on the occlusal surface. The axial reduction is between 1 and 1,5 mm with about 3° inclination of the walls. The

surface has to be as smooth as possible (Figure 3). The homothetic reduction of teeth is optimal (Figure 4). It can be simplified by initial depth guides preparation and by the use of a silicone key for control. Depending on the CAD/CAM technique variations in their position are possible. In intraoral scanning protocol, especially in the area of distal teeth, preparations over the gingival margin are preferred (Figure 5). In laboratory scanning of a dental stone working cast the level of the junctions is on or under the gingiva (no more than 1 mm in the depth of the gingival sulcus for prevention of the biological width).

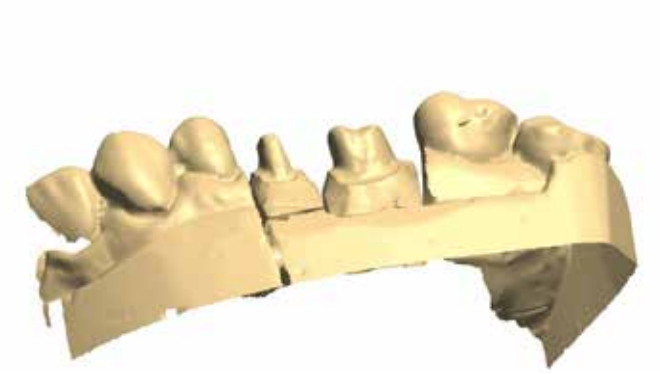

Figure 1. Chamfer preparation junctions

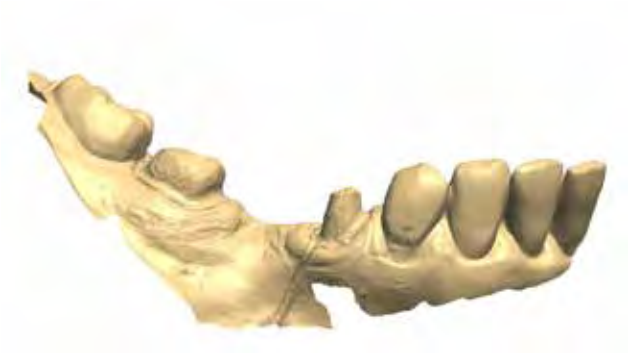

Figure 2. Radial shoulder preparation junctions

Figure 3. The prepared teeth surfaces has to be as smooth as possible

Figure 4. The homothetic reduction of teeth is optimal

Figure 5. In intraoral scanning protocol preparations over the gingival margin are preferred

Results and discussion

The width of the preparation junction depends of the volume and vitality of the tooth[3]. In stained teeth and those built with metal pins removal of more tissue provides a greater volume needed to disguise the dark color. In such cases the vestibular preparation under the level of the gingiva is preferable to ensure optimal aesthetics (Figure 6).

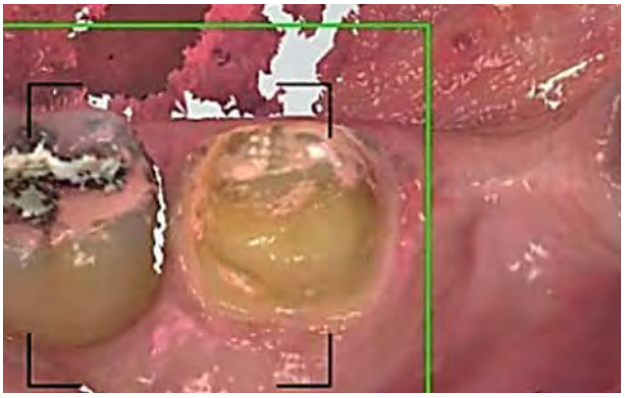

Figure 6. In stained teeth removal of more tissues and vestibular preparation under the level of the gingiva is desired

Preparation junction is determined also by CAD/CAM technology - the type of milling cutters, the way of impression taking (classical, with a real working cast and laboratory scanner or with a digital model made by the intraoral scanner). The rounded heads of the drills for example for the CAM 5 - S 2 Impression, VHF define the necessity of preparations with rounded angles (Figure 7) (unlike CEREC, Sirona where the milling cutters heads are flat with sharp angles and the optimal preparations are with sharp internal and external angles).

Figure 7. Preparations with rounded internal and external angles

Furthermore as more abilities for rotation in the CAM device as more complicated crown margins can be milled. For example CAM 5 - S 2 Impression, VHF is 5-axis CAM device. Its drills mill apart not only along the axes X, Y and Z, and also along two more additional - A (the axis to which the disc is rotated through 360 °) and B (an axis of rotation of the disc in the chamber ± 30 °).

Two types of fixed all-ceramic restorations CAD/CAM manufactures are possible – a full contour or a ceramic cap fabrication that is additionally finished with dentin and enamel ceramics, glaze and shades[8]. For full contour only shades and glaze are necessary. The full contour fabrication for distal teeth can be done only on digital impression, without pouring a real gypsum working cast[9]. This makes the process simple, reduces the technological time and the risk for mistakes in the additional laboratory steps[10].

The preparation junctions over the level of the gingiva make the process of impression taking (real or digital) easier, improve the local oral hygiene and therefore the periodontal health. The preparation junctions on or under the gingival margin do not disturb the biological width if they are positioned till 1 mm depth in the gingival sulcus.

Obtaining so called J - preparations (named on the shape of the English letter „J“) (Figure 8) must be promptly corrected, because the preserved enamel edge hinders further manipulations - adjustments and cementation.

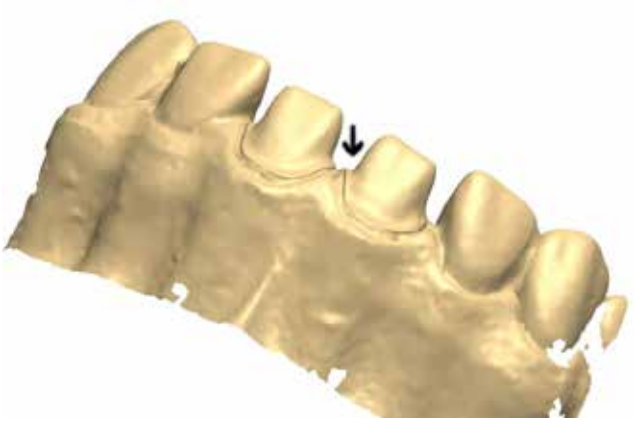

Figure 8. J – preparation

Conclusion

Knowledge about the criteria for selection the preparation junctions is essential for fabrication accurate and aesthetic CAD/CAM restorations. Number of factors have to be taken into consideration: the material of which the construction will be made; the type and condition of the retainer teeth, of the periodontium and the occlusion; the design software, the CAM setting and the type of drills; the working protocol – digital or classical type of impression; the cement and the method for fixation of the restorations.

The homothetic reduction of dental tissues releases enough volume (1,5 – 2 mm) for the ceramics that ensures strength and aesthetics. The rounded heads of the milling cutters define the necessity of preparations with rounded angles. The 5-axes CAM device simplifies the milling process and makes it more precise. Creation of a working model with the intraoral scanner is greatly facilitated by the positioning of preparation junctions over the gingival level. When the option with classical impression and scanning working model in the laboratory scanner is chosen the preparations may finish on the level of the gingiva or in the gingival sulcus but not deeper than 1 mm.

With proper correction of the J-preparations the problems with the following adjustments and cementation decrease significantly.

Note: The results of this paper were presented as a part of an invited lecture at the 21st BaSS Congress.

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Manuscripts should be prepared as a text file plus separate files for illustrations. The manuscripts should be set out as follows, with each section beginning on a separate sheet: Title page, Summary, Text, Acknowledgements if any, References, Tables and Captions of illustrations.

Submissions which do not conform to these guidelines will be returned to the author.

Title page. The title page should give the following information: 1) title of the paper which should be informative but concise, 2) initials, surname and the institution address of each author, 3) name, postal address, telephone and fax numbers, and e-mail adress of the author responsible for correspondence and to whom requests for offprints should be sent and 4) sources of support in the form of grants if any.

Summary. It should consist of not more than 250 words summarizing the contents of the paper. For OP, the abstract should be structured with the following headings: Background/Aim, Material and Methods, Results and Conclusions. For CR, the summary should consist of the following: Background/Aim, Case Report(s) and Conclusions. In other types of papers, the summary has no specific outline.

A list of 3-10 key words should be included, according to Index Medicus.

Text. The complete title should precede the text (but without authors and institution names). Headings should be appropriate to the nature of the paper. Normally, only two categories of headings should be used: major ones should be typed in capital letters in the centre of the page and underlined; minor ones should be typed in lower case (with an initial capital letter) at the left hand margin and underlined.

Main text of OR should be divided into: Introduction, Material and Methods, Results, Discussion and Conclusions.

Introduction should provide a concise summary of the background to the relevant field of research, outline the historical or logical origins of the study, introduce the specific problem and state the hypothesis to be tested.

Materials and Methods must contain sufficient detail about the properties and selection of the material (sample). Experimental, analytical and statistical methods should be described with enough detail. All drugs and equipment used should be identified precisely with the name and brief address of the manufacturer.

Manuscripts reporting studies on laboratory animals and on human subjects should include evidence that the research was ethically conducted.

Results should be presented in logical sequence. The text should not duplicate data provided in tables or figures.

Discussion should describe limitations of the study, if any, interpretate the data and inferences about the contribution of the study to the wider field of research. Repetition of preceding sections should be avoided.

Conclusions should be linked to the aim of the study and comment the relevance of the findings.

Main text of RP comprises Introduction, headings structured in a suitable way according to the subject treated, and Conclusions.

Main text or CR should be divided into Introduction, Case Report(s), Discussion and Conclusions.

All illustrations, labelled as **figures** (such as photographs, line drawings, charts or tracings) should be submitted as high-contrast prints, suitable for publications. Illustrations should have a final resolution of 300 dpi, and line drawings of 800-1200 dpi. They must be numbered with Arabic numerals in the same order as they are cited in the text. Photomicrographs should have the magnifications and details of staining techniques shown. Short explanatory captions of all illustrations should be typed on a separate sheet.

Tables should be typed on a separated sheet. Each table should have a short heading (title) above and any footnotes, suitably identified, below. Tables should be numbered consecutively with Arabic numerals. Do not submit tables as photographs. Ensure that each table is cited in the text. Abbreviations are not desirable.

References. References in the text should use superscript numerals as they appear in the list of references, with or without the name(s) of the author(s). The list of references at the end of the paper should be typed in double spacing on a separate sheet, arranged alphabetically and numbered, and should include all references cited in the text. For review papers, references can he arranged consecutively and numbered (by Arabic numerals) as they are cited. The accuracy of references is the responsibility of the author.

Titles of journals should be abbreviated as used by Index Medicus. The format for references should be: year-volume-first and last page. References to monographs should also include publisher and the page(s) referred to.

Examples:

Brown JS, Browne RM. Factors influencing the patterns of invasion of the mandible by squamous cell carcinoma. Int J Oral Maxillofac Surg, 1995; 24:417-426.

Sternbach RA. Pain patients - traits and treatment. New York, London, Toronto, Sydney, San Francisko: Academic Press, 1974, pp 20-30.

Koulourides T, Feagin F, Pigman W. Experimental changes in enamel mineral density. In: Harris RS (ed). Art and Science of Dental Caries Research. New York: Academic Press, 1968, pp 355-378.

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The Editor-in-Chief and Guest Editors of a journal have the right to select reviewers for a particular manuscript considering the knowledge and experience of the reviewers.

Purpose of a review

A review report provides the Editor-in-Chief with an expert opinion on the quality of the manuscript under consideration. It also supplies authors with explicit feedback on how to improve their papers to make them acceptable for publication in the journal. Although confidential, comments to the editors are not relayed to authors, any remarks that may help improve the quality of the manuscript are forwarded to the authors for their consideration. A good review report answers the following important areas:

- Is the work novel and of high standards?
- Is the manuscript written comprehensively enough to be understandable? If not, how could it be improved?
- Does the paper offer enough details of its methodology to reproduce the experiments?
- Do the experimental data support the declarations? If not, what other evidence may prove fruitful?
- What are the main findings of the paper? Is relevant work of other authors in the field appropriately acknowledged and references given to the previous literature?
- What kind of readers would benefit from the manuscript and why?
- In what further directions would it be feasible to take the current research?

After review of the manuscript by at least two independent experts, in addition to the views of the Editor-in-Chief, the decision is relayed to the authors, which may be categorized as:

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- Revisions required
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