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İstanbul Aydın Üniversitesi, Diş Hekimliği Fakültesi, Aydın Dental Dergisi özgün bilimsel araştırmalar ile uygulama çalışmalarına yer veren ve bu niteliği ile hem araştırmacılara hem de uygulamadaki akademisyenlere seslenmeyi amaçlayan hakem sistemini kullanan bir dergidir.

Istanbul Aydın University, Journal of The Faculty of Dentistry, Aydın Dental is A Double-Blind Peer-Reviewed Journal Which Provides A Platform For Publication Of Original Scientific Research And Applied Practice Studies. Positioned As A Vehicle For Academics And Practitioners To Share Field Research, The Journal Aims To Appeal To Both Researchers And Academicians.

İÇİNDEKİLER - CONTENTS

Message of the Editor;

Dear Readers of Journal of Aydin Dental (JAD),

After publishing the first issue in 2015, we are proud of publishing the second JAD now.

The JAD has already been added into the "TUBITAK DERGIPARK" (http://dergipark.ulakbim.gov.tr/adj/) within considerably short timeframe of six months.

In the upcoming period, we intend to indexed in ULAKBİM database and to make it commonly well known and looked for as a reference journal among the scientific circles because of its high academic reliability.

I would like to express my special thanks and appreciations to Prof. Dr. Rudiger Junker and all other academic colleagues because of their invaluable contributions to the second issue of JAD.

Best regards,
Prof. Dr. Jülide ÖZEN
Editor of Aydin Dental Journal

Editörden Mesaj;

Sayın Aydın Dental Journal Okurları,

İlk sayısını 2015 yılında yayınladığımız dergimizin 2. Sayısını basmaktan gurur duyuyoruz.

Dergimiz 6 ay gibi çok kısa bir sürede Tübitak Dergipark'a (http://dergipark.ulakbim.gov.tr/adj/) girmiş bulunmaktadır.

Hedefimiz ilerleyen süreçte ULAKBİM veritabanı listesine de girerek, dergimizin adını daha geniş kitlelere duyurarak seçkin, aranan ve akademik güvenilirliği yüksek bir duruma getirmektir.

Bu sayımızda değerli katkılarıyla beni ve dergimizi onurlandıran sayın hocam ve aynı zamanda çok değerli bir bilim adamı Prof. Dr. Rudiger Junker'e ve bilimsel yazılarıyla dergimize katkıda bulunan bütün akademisyen arkadaşlarıma teşekkür etmek istiyorum.

Saygılarımla,
Prof. Dr. Jülide ÖZEN
Aydın Dental Journal Editörü

Aydın Dental Journal

Journal homepage: http://dergipark.ulakbim.gov.tr/adj

Complete Root Coverage for Miller Class I and II – Recession Type Defects: Meta-Analysis of CAF+EMD Versus CAF+FCTG

Rüdiger JUNKER[1], Andreas LEINER[1], Daniela ZITSCH[1], Thomas ULRICH[1], Wilhelm FRANK[2], Adrian KASAJ[3]

ABSTRACT

Background: To the best of our knowledge, the equality of CAF + EMD and CAF + FCTG regarding complete root coverage in Miller class I and II recession-type defects is still uncertain.

Aim: The aim of the current paper is to compare the effect of CAF + EMD versus CAF + FCTG regarding complete root recession coverage. Thereby, equality on the longer term of both therapeutic options is hypothesized (H0- hypothesis).

Materials and methods: Three reviewers searched independently within the electronic database Pubmed/Medline. Only RCTs reporting quantitative data for the outcome variable percentage complete root coverage (%CRC) for the therapeutic options CAF + EMD or CAF + FCTG were considered. Additionally a manual search in the reference lists of all included publications was accomplished.

Results: After electronical and manual search for relevant studies, the three independent reviewers (DZ, TU, AL) screened 552 titles, resulting in 102 abstracts and 41 full-texts. Eventually, twenty-five papers could be included for meta-analysis. By comprehensively comparing data from RCTs for the outcome variable "percentage complete root coverage", statistically significant weighted mean differences in favor of CAF + FCTG were found at 6, 12 and 24 months.

Conclusion: Regarding percentage complete root coverage, CAF + EMD is not as effective as CAF + FCTG for Miller class I and II recession- type defects.

Keywords: *Miller class I and II recession-type defects, root coverage, coronally advanced flap, free connective tissue graft, enamel matrix derivative*

[1] *Department of Prosthodontics and Biomaterials, Danube Private University (DPU), Krems, Austria*
[2] *Department of Health management, - economics, and - system research, Danube Private University (DPU), Krems, Austria*
[3] *Department of Operative Dentistry and Periodontology, University of Mainz, Germany*

Introduction

Gingival recession is defined as displacement of the gingival margin apical to the cemento-enamel junction with root surface exposure (Wennström 1996). Recession-type defects can be seen in subjects of all ages with suboptimal as well as with excellent oral hygiene (Sagnes & Gjermo 1976). Possible causes are for example periodontal disease, traumatic tooth brushing, as well as malposition of teeth or orthodontic tooth movement out of the bony envelope (Gorman 1967; Boyd 1978; Miller & Allen 1996).

Main indications for root coverage procedures are esthetic / cosmetic demands, root sensitivity as well as changing the topography of the marginal soft tissue to facilitate plaque control (Wennström, et al. 2008; Zuhr & Hürzeler 2011). Interestingly, Miller (1985) created a classification system for recession-type defects to predict treatment success. Thereby, it is presumed that for Class I and II recession–type defects (i.e. recession within the attached gingiva and recession up to the mucogingival margin, respectively) complete root coverage can be achieved.

Up to now, the so-called coronally advanced flap (CAF) combined with a free connective tissue graft (FCTG) is considered the "gold standard" for root coverage therapy (Cairo, et al. 2014; Chambrone & Tatakis 2015). Consequently, alternative techniques are generally compared to CAF + FCTG and evaluated according to their ability to reduce recession and achieve root coverage (Oates, et al. 2003, Academy-Report 2005, Chambrone, et al. 2009). During the last decades, an alternative method avoiding a second surgery for the FCTG, the „Coronally Positioned Flap" in combination with "Enamel Matrix Derivative" (CAF + EMD) gained attention (Modica et al. 2000) However, to the best of our knowledge, the equality of CAF + FCTG and CAF + EMD regarding complete root coverage in Miller class I and II recession-type defects is still uncertain. Therefore, the aim of the current paper is to compare the effect of CAF + EMD versus CAF + FCTG regarding complete root recession coverage. Thereby, equality on the longer term of both therapeutic options is hypothesized (H_0- hypothesis).

Material and Methods

Search Strategy

Three reviewers (Daniela Zitsch (DZ), Thomas Ulrich (TU), Andreas Leiner (AL)) searched independently within the electronic database PubMed/Medline, US National Library of Medicine, National Institute of Health (http://www.ncbi.nlm.nih.gov/pubmed) for relevant publications.

The typewritten search strategy for „Coronally Advanced Flap" in combination with a "free connective tissue graft" (CAF + FCTG) was: (Recession coverage OR root coverage OR plastic periodontal surgery) AND (FCTG OR free connective tissue graft OR connective tissue graft OR subepithelial graft)

Thereafter, that search strategy for CAF + FCTG was translated by the search engine of Pubmed/Medline to:
((Recession[All Fields] AND ("AHIP Cover"[Journal] OR "coverage"[All Fields])) OR (("plant roots"[MeSH Terms] OR ("plant"[All Fields] AND "roots"[All Fields]) OR "plant roots"[All Fields] OR "root"[All Fields]) AND ("AHIP Cover"[Journal] OR "coverage"[All Fields])) OR (("plastics"[MeSH Terms] OR "plastics"[All Fields] OR "plastic"[All Fields]) AND periodontal[All Fields] AND

(“surgery”[Subheading] OR “surgery”[All Fields] OR “surgical procedures, operative”[MeSH Terms] OR (“surgical”[All Fields] AND “procedures”[All Fields] AND “operative”[All Fields]) OR “operative surgical procedures”[All Fields] OR “surgery”[All Fields] OR “general surgery”[MeSH Terms] OR (“general”[All Fields] AND “surgery”[All Fields]) OR “general surgery”[All Fields]))) AND (FCTG[All Fields] OR (free[All Fields] AND (“connective tissue”[MeSH Terms] OR (“connective”[All Fields] AND “tissue”[All Fields]) OR “connective tissue”[All Fields]) AND (“transplants”[MeSH Terms] OR “transplants”[All Fields] OR “graft”[All Fields])) OR ((“connective tissue”[MeSH Terms] OR (“connective”[All Fields] AND “tissue”[All Fields]) OR “connective tissue”[All Fields]) AND (“transplants”[MeSH Terms] OR “transplants”[All Fields] OR “graft”[All Fields])) OR (subepithelial[All Fields] AND (“transplants”[MeSH Terms] OR “transplants”[All Fields] OR “graft”[All Fields])))

In analogue, the typewritten search strategy for “Coronally Advanced Flap” in combination with “Enamel matrix Derivative” (CAF + EMD) was: (Recession coverage OR root coverage OR plastic periodontal surgery) AND (Emdogain OR EMD OR Amelogenin OR enamel proteins OR growth factor)

Thereafter, that search strategy for CAF + EMD was translated by the search engine of PubMed/Medline to:
((Recession[All Fields] AND (“AHIP Cover”[Journal] OR “coverage”[All Fields])) OR ((“plant roots”[MeSH Terms] OR (“plant”[All Fields] AND “roots”[All Fields]) OR “plant roots”[All Fields] OR “root”[All Fields]) AND (“AHIP Cover”[Journal] OR “coverage”[All Fields])) OR ((“plastics”[MeSH Terms] OR “plastics”[All Fields] OR “plastic”[All Fields]) AND periodontal[All Fields] AND (“surgery”[Subheading] OR “surgery”[All Fields] OR “surgical procedures, operative”[MeSH Terms] OR (“surgical”[All Fields] AND “procedures”[All Fields] AND “operative”[All Fields]) OR “operative surgical procedures”[All Fields] OR “surgery”[All Fields] OR “general surgery”[MeSH Terms] OR (“general”[All Fields] AND “surgery”[All Fields]) OR “general surgery”[All Fields]))) AND ((“enamel matrix proteins”[Supplementary Concept] OR “enamel matrix proteins”[All Fields] OR “emdogain”[All Fields]) OR EMD[All Fields] OR (“amelogenin”[MeSH Terms] OR “amelogenin”[All Fields]) OR ((“dental enamel”[MeSH Terms] OR (“dental”[All Fields] AND “enamel”[All Fields]) OR “dental enamel”[All Fields] OR “enamel”[All Fields]) AND (“proteins”[MeSH Terms] OR “proteins”[All Fields])) OR (“intercellular signaling peptides and proteins”[MeSH Terms] OR (“intercellular”[All Fields] AND “signaling”[All Fields] AND “peptides”[All Fields] AND “proteins”[All Fields]) OR “intercellular signaling peptides and proteins”[All Fields] OR (“growth”[All Fields] AND “factor”[All Fields]) OR “growth factor”[All Fields])

Screening Process

The three independent reviewers (DZ, TU, AL) searched titles and evaluated abstracts as well as fulltexts for meta-analytical inclusion. Any difference between the reviewers was resolved by discussion. Eventually, for papers selected for meta-analysis, data extraction sheets were developed, tested and operated (Table 1). Thereafter, data for meta-analysis were synopsized in an excel-sheet.

Manual Search

Additionally to the search in the electronic database PubMed/Medline, a manual search for relevant studies was performed independently by the three reviewers (DZ, TU, AL). Thereby, the references of the studies included for meta- analysis were screened according to the above detailed process (i.e. title-, abstract-, and full text-analysis).

Outcome Variable

In this paper the outcome variable percentage complete root coverage (%CRC) is meta-analyzed.

Thereby, the formula for the outcome variable was:

$$\%CRC = \frac{\text{number of teeth with complete coverage}}{\text{number of treated teeth}}$$

Inclusion- / Exclusion Criteria

To test the hypothesis of equality on the longer term of both therapeutic options only randomized controlled clinical trials (RCTs) were considered for the current systematic review / meta- analysis. Further, studies with a publishing date before the year 2000 were excluded. Moreover, only RCTs with at least 10 patients per treatment protocol were included. Thereby, only reports on Miller class I and II recession- type defects were considered. Studies with Miller Class III and IV recession– type defects were excluded. It goes without saying that only studies using either FCTG or EMD in combination with a "Coronally Advanced Flap" were included. For comparison, the included studies should present quantitative data at 6, 12, 18 and/or 24 months after surgery.

Quality Assessment

Risk of bias assessment of the included articles was accomplished. It was done according to the „Cochrane Handbook" (http://handbook.cochrane.org/chapter _ 8 / 8 _ 5the _ coch- rane_collaborations_tool_for_ assessing_risk_of_bias-htm).Thereby, five main criteria were analyzed: random sequence generation (RSG), allocation concealment (ALC), blinding of outcome assessment (BOA), incomplete outcome (ICD), selective reporting (SLR). Accordingly, by judging a paper for all five criteria as being associated with a low risk of bias, the publication was judged as being associated with a low risk of bias. Further, by judging a paper for three to four criteria as being associated with a low risk of bias, the paper itself was judged as being associated with a moderate risk of bias. Whereas, by judging a paper for less than three criteria as being associated with a low risk of bias, the publication itsef was judged as being associated with a high risk of bias (Higgins & Green 2011).

Cochrane Review Manager / Meta-analytic Approach

The so-called „Cochrane Review Manager (RevMan)" (current version 5.3.5; http:// community.cochrane.org / editorial-and-publishing-policy-resource/review-manager-revman) is a software program providing guidance to write systematic reviews and / or meta-analyses. All relevant data - the authors agreed to analyze all parameters on tooth level and not on patient level - at 6, 12, 18 and / or 24 months of all included studies were conveyed to RevMan version 5.3.5 and meta-analyzed. Thus, for comprehensive comparison at different time points, „weighted means" for the outcome variable percentage complete root coverage (%CRC) were determined by the calculator program of RevMan version 5.3.5. Further, RCTs evaluating CAF + EMD versus CAF + FCTG per protocol were compared directly. However, meta-analysis

with RevMan version 5.3.5 is only possible, if standard deviations are given. It goes without saying that for the variable %CRC no standard deviations could be retrieved from the included RCTs. Therefore, for all %CRC-data a standard deviation tending to zero and thereby not effecting the meta-analysis (i.e. 0.001) was operated. Further, for directly compared data statistical heterogeneity was tested. As a result, either fixed- or random-statistical models were operated. A significance level of 0.05 was chosen. Additionally, forest plots were generated.

Heterogeneity

Heterogeneity was defined and tested according to the „Cochrane Handbook" for systematic reviews (http://handbook. cochrane .org / chapter_9/9_5_2_ identifying _ and _ measuring_heterogeneity.htm). Thereby, RevMan version 5.3.5 is operating a chi-squared test (χ^2, or Chi^2) to determine heterogeneity and its impact on the meta-analysis is represented with I^2. The test evaluates whether observed differences in results are compatible with chance alone. A low p-value ($p < 0.1$ or a large chi-squared statistic relative to its degree of freedom) provides evidence of heterogeneity of intervention effects (i.e. variation in effect estimates beyond chance). The interpretation of I^2 can be done as follows: 0% to 40% might not be important, 30% to 60% may represent moderate heterogeneity, 50% to 90% may represent substantial heterogeneity and 75% to 100% might be seen as considerably heterogeneity (Higgins & Green 2011).

Detailed Hypotheses

As stated above, the aim of the current meta-analysis is to compare the effects of CAF + EMD and CAF + FCTG regarding root recession coverage. Thereby, equality on the longer term of both therapeutic options is hypothesized (H_0- hypothesis). More in detail, equality for the outcome variable percentage complete root coverage (%CRC) is hypothesized.

Results

Selection of the Studies

After electronical and manual search for relevant studies, the three independent reviewers (DZ, TU, AL) screened 552 titles, resulting in 102 abstracts and 41 full-texts. Eventually, twenty-five papers could be included for the meta-analysis (Fig. 1). After fulltext reading excluded papers are listed in Table 3. Reasons for exclusion are given.

Included studies

In the end the following studies could be included:

Table 2. *Included Studies*

Study	Characteristics
Abolfazli et al. 2009	Patients: 12 Recession defects: 24 Therapies: CAF + FCTG vs. CAF + EMD
Alkan & Parlar 2011	Patients: 12 Recession defects: 24 Therapies: CAF + EMD vs. CAF + FCTG
Alkan & Parlar 2013	Patients: 12 Recession defects: 56 Therapies: CAF + EMD vs. CAF + FCTG
Cairo et al. 2012recession reduction (RecRed	Patients: 29 Recession defects: 29 Therapies: CAF vs. CAF + FCTG
Cardaropoli et al. 2012	Patients: 18 Recession defects: 22 CAF + PCM vs. CAF + FCTG
Castellanos et al. 2006	Patients: 22 Recession defects: 22 Therapies: CAF vs. CAF + EMD
Cordaro et al. 2012	Patients: 12 Recession defects: 58 Therapies: CAF vs. CAF + EMD
Cortellini et al. 2009	Patients: 85 Recession defects: 85 Therapies: CAF vs. CAF + FCTG
Cueva et al. 2004controlled, clinical investigation was to evaluate the differences in clinical parameters of root coverage procedures utilizing coronally advanced flaps (CAF	Patients: 17 Recession defects: 58 Therapies: CAF vs. CAF + EMD
Hägewald et al. 2002	Patients: 36 Recession defects: 72 Therapies: CAF + Placebo vs. CAF + EMD
Jaiswal et al. 2012	Patients: 20 Recession defects: 46 Therapies: CAF vs. CAF + EMD
Kuis et al. 2013	Patients: 37 Recession defects: 114 Therapies: CAF vs. CAF + FCTG
Kumar & Murthy 2013while keratinized tissue width (KTW	Patients: 12 Recession defects: 24 Therapies: CAF + FCTG vs. CAF + PCG

McGuire & Nunn 2003 McGuire & Scheyer 2010	Patients: 20 Recession defects: 40 Therapies: CAF + EMD vs. CAF + FCTG Patients: 25 Recession defects: 50 Therapies: CAF + FCTG vs. CAF + CM
McGuire et al. 2014	Patients: 30 Recession defects: 60 Therapies: CAF + FCTG vs. CAF + HPDGF + β-TCP
Modica et al. 2000one site was randomly assigned to the test group and the contralateral site to the control group. The treatment consisted of a CAF procedure with (test	Patients: 12 Recession defects: 28 Therapies: CAF vs. CAF + EMD
Del Pizzo et al. 2005	Patients: 15 Recession defects: 30 Therapies: CAF vs. CAF + EMD
Roman et al. 2013	Patients: 42 Recession defects: 68 Therapies: CAF + FCTG vs. CAF + FCTG + EMD
Salhi et al. 2014 Sayar et al. 2013	Patients: 40 Recession defects: 40 Therapies: CAF + FCTG vs. FCTG + Pouch Technique Patients: 13 Recession defects: 40 Therapies: CAF + FCTG vs. CAF + EMD
da Silva et al. 2004	Patients: 11 Recession defects: 22 Therapies: CAF vs. CAF + FCTG
Spahr et al. 2005	Patients: 30 Recession defects: 60 Therapies: CAF + Placebo vs. CAF + EMD
Zucchelli, Marzadori, et al. 2014	Patients: 50 Recession defects: 50 Therapies: CAF + FCTG vs. CAF + FCTG + removed LST
Zucchelli, Mounssif, et al. 2014	Patients: 50 Recession defects: 149 Therapies: CAF vs. CAF + FCTG

Risk of Bias

In the present systematic review / meta-analysis of the current literature, three included studies were judged as being associated with a low risk of bias (Cortellini et al. 2009, McGuire & Nunn 2003 and Roman et al. 2013), whereas twenty studies were judged as being associated with a moderate risk of bias (Abolfazli et al. 2009, Alkan & Parlar 2011, Alkan & Parlar 2013, Cairo et al. 2012recession reduction (RecRed, Cardaropoli et al. 2012, Cordaro et al. 2012, da Silva et al. 2004, del Pizzo et al. 2005, Hägewald et al. 2002, Jaiswal et al. 2012, Kuis et al. 2013, Kumar & Murthy 2013while keratinized tissue width (KTW, McGuire & Scheyer 2010, McGuire et al. 2014, Modica et al. 2000one site was randomly assigned to the test group and the contralateral site to the control group. The treatment consisted of a CAF procedure with (test, Salhi et al. 2014, Sayar et al. 2013, Spahr et al. 2005, Zucchelli Mounssif, et al. 2014 and Zucchelli, Marzadori, et al. 2014), and two studies were judged as being associated with a high risk of bias (Castellanos et al. 2006 and Cueva et al. 2004)(Tab. 4).

Percentage Complete Root Coverage (%CRC)

RCTs comprehensively compared at six months

For meta- analysis of percentage complete root coverage (%CRC) at six months the studies of Cordaro et al. (2012); Cueva et al. (2004); Modica et al. (2000with the adjunct of EMD for test sites, was performed. Clinical measurements (recession length, keratinized tissue, probing depth, and clinical attachment level) for CAF + EMD and the studies of Cairo et al. (2012); Cortellini et al. (2009); Kuis et al. (2013); McGuire et al. (2014); Roman et al. (2013); Salhi et al. (2014); da Silva et al. (2004); Zucchelli, Mounssif, et al. (2014recession reduction (RecRed) for CAF + FCTG could be included.

At six months after root coverage surgery a weighted mean percentage complete root coverage of 54.1% (SD: 19.3%) for CAF + EMD was calculated. For CAF + FCTG a weighted mean percentage complete root coverage of 78.8% (SD: 18.2%) was found. Thereby, the calculated weighted mean difference of 24.7% (95% CI [19.8%, 29.7%]) in favor of CAF + FCTG was statistically significant (Fig. 3).

However, it should be kept in mind that only two of the included studies were judged as being associated with a low risk of bias (Cortellini et al. 2009; Roman et al. 2013), eight studies were judged as being associated with a moderate risk of bias (Cairo et al. 2012; Cordaro et al. 2012; Kuis et al. 2013; McGuire et al. 2014; Modica et al. 2000; Salhi et al. 2014; da Silva et al. 2004; Zucchelli, Mounssif, et al. 2014)recession reduction (RecRed and one study as being associated with a high risk of bias (Cueva et al. 2004)controlled, clinical investigation was to evaluate the differences in clinical parameters of root coverage procedures utilizing coronally advanced flaps (CAF.

RCTs directly compared at six months

At six months, no publication reported the effect difference for the outcome variable %CRC directly.

RCTs comprehensively compared at twelve months

For meta- analysis at twelve months the studies of Abolfazli et al. (2009); Alkan & Parlar (2011); Castellanos et al. (2006); McGuire & Nunn (2003) for CAF + EMD and the studies

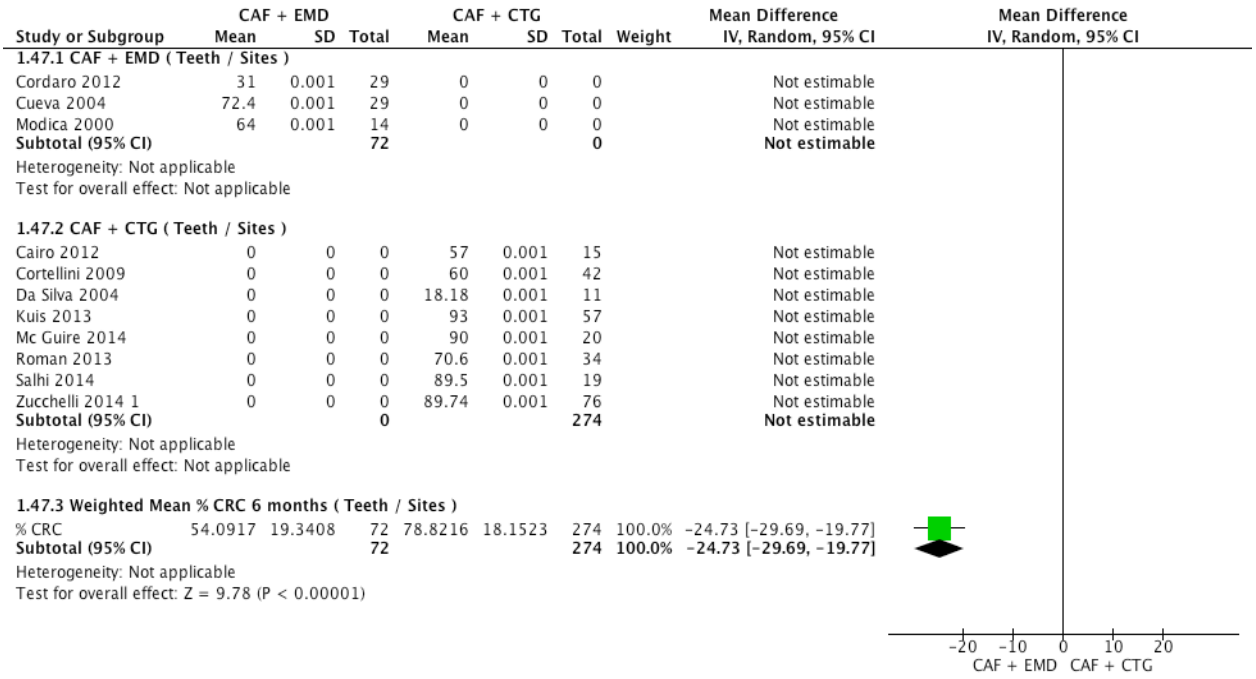

Fig. 2. *Percentage complete root coverage at six months*

of Abolfazli et al. (2009); Alkan & Parlar (2011); Cardaropoli et al. (2012); Kuis et al. (2013); McGuire & Nunn (2003); Roman et al. (2013); Zucchelli, Marzadori, et al. (2014); Zucchelli, Mounssif, et al. (2014) for CAF + FCTG could be included.

At twelve months after root coverage surgery a weighted mean percentage complete root coverage of 67.0 % (SD: 16.2%) for CAF + EMD was calculated. For CAF + FCTG a weighted mean percentage complete root coverage of 78.4% (SD: 14.7%) was found. Thereby, the calculated weighted mean difference of 11.5% (95% CI [7.1%, 15.9%]) in favor of CAF + FCTG was statistically significant (Fig.3).

However, it should be understood that only two studies were judged as being associated with a low risk of bias (McGuire & Nunn 2003; Roman et al. 2013), six studies were judged as being associated with a moderate risk of bias (Abolfazli et al. 2009; Alkan & Parlar 2011; Cardaropoli et al. 2012; Kuis et al. 2013; Zucchelli, Marzadori, et al. 2014; Zucchelli, Mounssif, et al. 2014) and one study as being associated with a high risk of bias (Castellanos et al. 2006).

RCTs directly compared at twelve months

At twelve months after plastic periodontal surgery three papers comparing percentage complete root coverage for CAF + EMD versus CAF + FCTG per protocol, i.e. directly, were eventually included in the current meta-analysis (Abolfazli et al. 2009; Alkan & Parlar 2011; McGuire & Nunn 2003) (Fig.4). Thereby, Abolfazli et al. (2009) found a percentage of complete root coverage of 50% for CAF + EMD and 58.3% for CAF + FCTG. The mean difference was 8.0% in favor of CAF + FCTG. This difference was statistically significant (Fig. 4). In contrast, McGuire & Nunn (2003) found a percentage of complete root coverage of 89.5% for CAF + EMD and 79% for CAF

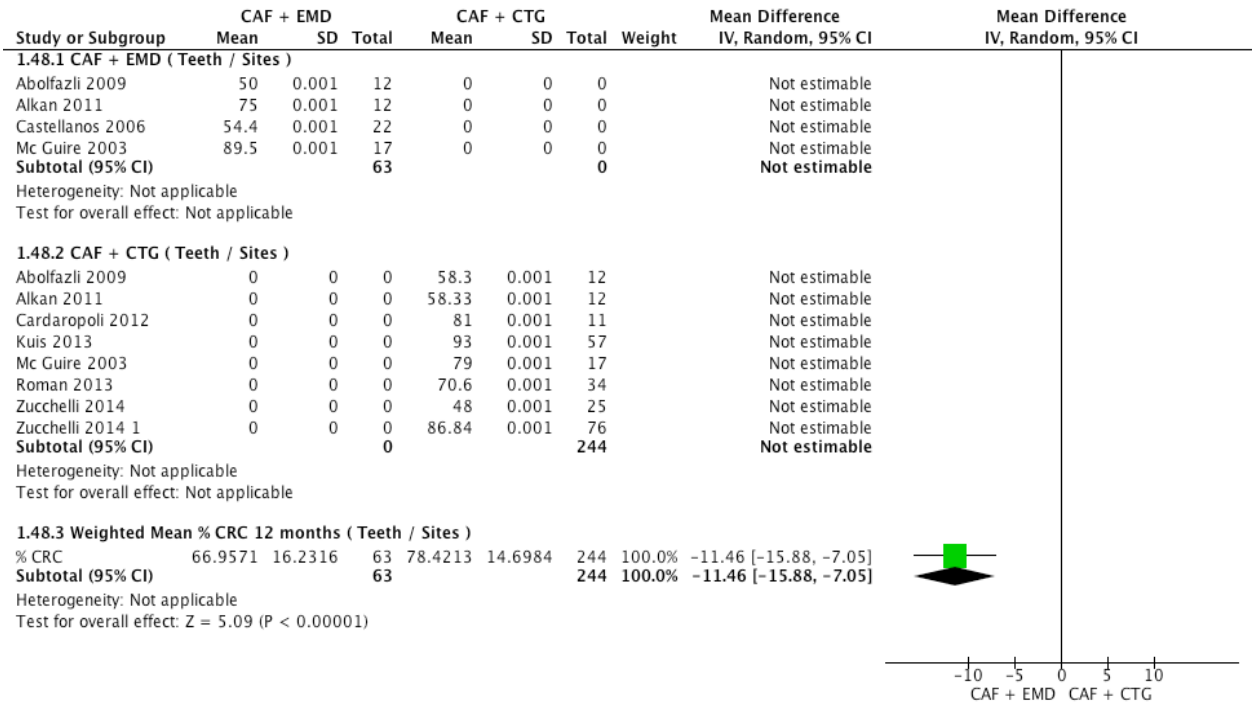

Fig. 3. *Percentage complete root coverage at twelve months*

+ FCTG. The mean difference was 10.5% in favor of CAF + EMD. Again, this difference was statistically significant (Fig. 4). Further, Alkan & Parlar (2011) reported a percentage of complete root coverage of 75% for CAF + EMD and 58.3% for CAF + FCTG. The mean difference was 16.7% in favor of CAF + EMD. This difference was statistically significant (Fig. 4). In total, the weighted mean difference between CAF + EMD and CAF + FCTG of all three studies together was 6.3% (95% CI [-7.7%, 20.3%]). This difference was not statistically significant (Fig. 4).

Additionally, it should be mentioned that statistical heterogeneity across the studies could be found (Heterogeneity: Chi^2 = 2068926160.98, df = 2 ($P < 0.00001$); I^2 = 100%). Moreover, it should be kept in mind that only one study was judged as being associated with a low risk of bias (McGuire & Nunn 2003), whereas two studies were judged as being associated with a moderate risk of bias (Abolfazli et al. 2009; Alkan & Parlar 2011).

Comparing comprehensively versus directly at twelve months

The weighted mean difference of comprehensively compared data was statistically significant in favor of CAF + FCTG (11.6%; 95% CI [7.1%, 15.9%]), whereas the weighted mean difference of directly compared data (6.3% in favor of CAF + EMD; 95% CI [-7.7%, 20.3%]) was not statistically significant.

RCTs comprehensively compared at 24 months

For meta- analysis at twenty-four months the studies of Abolfazli et al. (2009); Cordaro et al. (2012); Del Pizzo et al. (2005); Spahr et al. (2005) for CAF + EMD and the studies of Abolfazli et al. (2009); Kuis et al. (2013) for CAF + FCTG could be included.

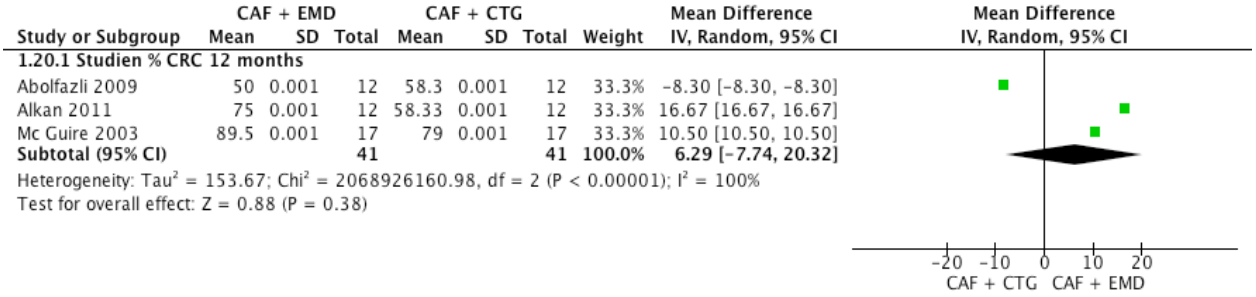

Fig. 4. *Percentage complete root coverage at twelve months (directly compared)*

At twenty-four months after root coverage surgery a weighted mean percentage complete root coverage of 40.5% (SD: 21.6%) for CAF + EMD was calculated. For CAF + FCTG a weighted mean percentage complete root coverage of 85.5% (SD: 8.7%) was found. Thereby, the calculated weighted mean difference of 45.0% (95% CI [40.0%, 50.0%]) in favor of CAF + FCTG was statistically significant (Fig. 5).

Further, all five studies were judged as being associated with a moderate risk of bias (Abolfazli et al. 2009; Cordaro et al. 2012; Kuis et al. 2013; Del Pizzo et al. 2005; Spahr et al. 2005).

RCTs directly compared at twenty-four months

At twenty-four months only one study comparing CAF + FCTG versus CAF + EMD per protocol, i.e. directly, was eventually included in the current paper (Abolfazli et al. 2009). For CAF + EMD 25% complete root coverage and for CAF + FCTG 66.6% complete root coverage was found. This difference was statistically significant in favor of CAF + FCTG.

Discussion

Briefly, the current meta-analysis aimed to compare the effects of CAF + EMD versus CAF + FCTG regarding root recession coverage. Thereby, it was hypothesized (H_0-hypothesis) that for the outcome variable "percentage complete root coverage" the results achieved by CAF + EMD do not differ statistically significant from CAF + FCTG on the longer term.

By comprehensively comparing data from RCTs for the outcome variable "percentage

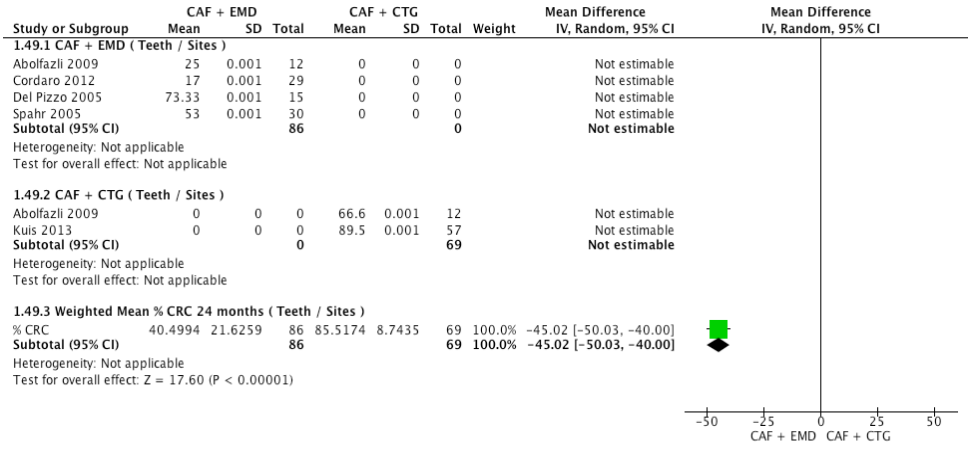

Fig. 5. *Percentage complete root coverage at twenty-four months*

complete root coverage", statistically significant weighted mean differences of 24.7% (95% CI [29.7%, 19.8%]), 11.5% (95% CI [7.1%, 15.9%]) and 45.0% (95% CI [40.0%, 50.0%]) in favor of CAF + FCTG were found at 6, 12 and 24 months, respectively. At 6 months there were no studies reporting mean differences between CAF + EMD and CAF + FCTG directly. In contrast to comprehensively compared data from RCTs, for RCTs directly comparing CAF + EMD versus CAF + FCTG, no statistically significant difference was found at twelve months. However, at 24 months a statistically significant difference in favor of CAF + FCTG was found. Thereby, it should be kept in mind that most of the studies were not judged as having a low risk of bias and statistical heterogeneity was found.
Therefore, we tend to reject the H_0 – hypothesis of no difference and we have the tendency to accept a superiority of CAF + FCTG regarding the outcome variable percentage complete root coverage on the longer term. It should be kept in mind that comprehensively comparing RCTs resulted in weighted mean percentages of complete root coverage of 78.8% (SD: 18.2%), 78.4% (SD: 14.7%), and 85.5% (SD: 8.7%) for CAF + FCTG in Miller class I and II recession-type defects at six, twelve, and twenty-four months after plastic periodontal surgery, respectively. Thus, as presumed by Miller (1985) in general complete root coverage can be achieved in Class I and II recession–type defects and obviously the mean percentages of complete root coverage increase over time. However, it should be understood that even with the so-called "gold standard" prediction of complete root coverage is not possible.

Somehow in contrast, comprehensively comparing RCTs resulted in weighted mean percentages of complete root coverage of only 54.1% (SD: 19.3%), 67.0 % (SD: 16.2%), and 40.5% (SD: 21.6%) for CAF + EMD in Miller class I and II recession-type defects at six, twelve, and twenty-four months after plastic periodontal surgery, respectively. It goes without saying that with this method the clinician cannot predict complete root coverage at all.

Moreover, conclusions of earlier reports that CAF + EMD resulted in root coverage similar to CAF + FCTG but without the morbidity and potential clinical difficulties associated with the donor site surgery (McGuire and Nunn 2003; Alkan and Parlar 2011, 2013; Sayer et al. 2013) must be - at least regarding percentage of complete root coverage - interpreted with caution.

Conclusion

Within the limits of the current meta-analysis of the literature regarding plastic periodontal surgery of Miller class I and II recession- type defects it is concluded that CAF + EMD is not as effective as CAF + FCTG as regards percentage complete root coverage.

Appendix

Table 1. *Data extraction sheet*

Publication (authors, title, journal, date)		
Abstract		
Earlier reports of same study		
Study design	Study design	
	Treatment test group	
	Treatment control group	
	Split mouth	
	Study duration	
	Funding	
Methodological quality	Allocation concealment	
	Surgeon blinding	
	Examiner blinding	
	Sequence generation	
	Sample size calculation	
	Dropouts	
Intervention	Type surgery	
	FCTG from tuberosity / palate	
	Pre-surgical treatment of site (scaling/ rootplaning, reducing root convexity, AB)	
	Healing / complications	
	Treatment of complications	
	Supportive Periodontal Therapy	

Inclusion criteria patients / sites	Number of patients (M/F/Age)	
	Other inclusion criteria patients	
	Number of sites (= teeth)	
	Miller class	
	Other inclusion criteria sites	
	Smokers	
	Single / multiple recessions	
	Upper / lower jaw	
	Type of teeth	
Outcome variable **Frequency of complete root-coverage (%CRC)** 6 / 12/ 24 months		
Control variable for oral hygiene API [%] PBI [%]		

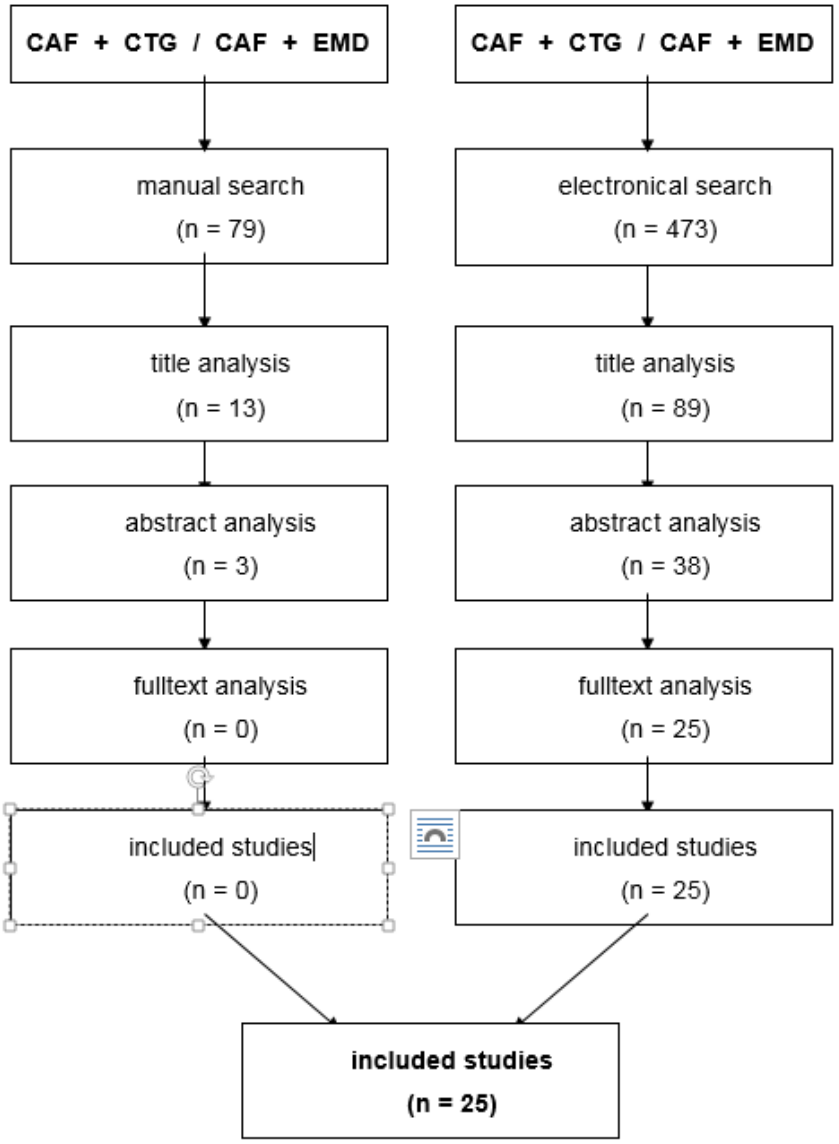

Fig. 1. *Study selection*

Table 3. *Excluded studies (RCTs) after fulltext analysis with reason*

Publication ***electronical search***	**Intervention**	**Test group**	**Control group**	**Reason(s) for exclusion**
Berlucchi et al. 2002	Recession coverage Miller Class I and II	CAF + EMD	CAF + FCTG + EMD	no RCT
Berlucchi et al. 2005	Recession coverage Miller Class I and II	CAF + EMD	no	no RCT
Cheng et al. 2007	Recession coverage Miller Class I and II	CAF + EMD	CAF or CAF + CRSC	no RCT
Cheng et al. 2014	Recession coverage Miller Class I, II and III	CAF + EMD or CAF + FCTG + EMD	CAF or CAF + FCTG	no RCT and Miller Class III recessions
Lafzi et al. 2007	Recession coverage Miller Class I and II	CAF + FCTG (P-flap)	CAF + FCTG (P-teeth)	only 8 patients
Martorelli de Lima et al. 2006	Recession coverage Miller Class I and II	CAF + FCTG	no	no RCT (no control group)
Mc Guire et al. 2012	Recession coverage Miller Class I and II	CAF + EMD	CAF + FCTG	only 9 patients
Nart et al. 2012	Recession coverage Miller Class II and III	CAF + FCTG	no	no RCT and Miller Class III recessions
Nemcovsky et al. 2004	Recession coverage Miller Class I and II	CAF + EMD	CAF + FCTG	no RCT
Pilloni et al. 2006	Recession coverage Miller Class I and II	CAF + EMD	no	single study with outcomes only at 18 months, outcomes are not comparable
Pini- Prato et al. 2010	Recession coverage Miller Class I, II and III	CAF + FCTG	CAF	Miller Class III recession
Tatakis et al. 2015	Recession coverage Miller Class I and II	CAF + EMD or CAF + ADMG	CAF + FCTG	no RCT
Tonetti et al. 2014	Recession coverage Miller Class I, II and III	CAF + EMD or CAF + GTR	CAF + FCTG	no RCT
Publication ***manual search***	**Intervention**	**Test group**	**Control group**	**Reason(s) for exclusion**
Buti et al. 2013	Recession coverage Miller Class I and II	CAF + EMD or CAF + CM	CAF + FCTG	no RCT
Montebugnoli et al. 2012	Recession coverage Miller Class I and II	BT	LMCAF	other surgical therapies
Zucchelli et al. 2005	Recession coverage Miller Class I and II	CAF	no	other surgical therapy

Table 4. *Quality assessment (risk of bias)*

Studies	*RSG*	*ALC*	*BOA*	*ICD*	*SLR*	*Risk of bias*
Abolfazli et al. (2009)	un	un	Y	N	N	Moderate
Alkan & Parlar (2011)	ad	un	un	N	N	Moderate
Cairo et al. (2012)	un	un	Y	N	N	Moderate
Cardaropoli et al. (2012)	ad	un	Y	N	N	Moderate
Castellanos et al. (2006)	inad	un	un	N	N	High
Cordaro et al. (2012)	ad	un	Y	N	N	Moderate
Cortellini et al. (2009)	ad	ad	Y	Y	N	Low
Cueva et al. (2004)	ad	un	N	N	Y	High
Da Silva et al. (2004)	ad	un	N	N	N	Moderate
Del Pizzo et al. (2005)	ad	un	Y	N	N	Moderate
Kuis et al. (2013)	ad	un	Y	N	N	Moderate
Mc Guire et al. (2003)	ad	un	Y	N	N	Low
Mc Guire et al. (2014)	ad	un	Y	N	N	Moderate
Modica et al. (2000)	ad	un	Y	N	N	Moderate
Roman et al. (2013)	ad	ad	Y	N	N	Low
Salhi et al. (2014)	ad	un	N	N	N	Moderate
Spahr et al. (2005)	un	un	Y	N	N	Moderate
Zucchelli et al. (2014, 41 S. 396-403)	ad	un	Y	N	N	Moderate
Zucchelli et al. (2014, 41 S. 806-813)	ad	un	Y	N	N	Moderate

ad: adequate; inad: inadequate; y: yes, n: no,
un: unclear;

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The Effect of Bleaching Treatment and Tea on Color Stability of Two Different Resin Composites

Funda Öztürk BOZKURT[1], Tuğba Toz AKALIN[1], Burcu GÖZETİCİ[2], Gencay GENÇ[2], Harika GÖZÜKARA BAĞ[3]

ABSTRACT

Aim: The aim of this study was to evaluate the staining susceptibility of two resin composites after bleaching procedure.

Materials and Methods: Twenty four specimens were prepared from GC Kalore (GC Dental, Tokyo, Japan) and Filtek Z550 (3M ESPE, Seefeld, Germany). Twelve of the specimens were bleached with an office bleaching agent (Perfection White, Premier Dental, USA) whereas twelve of them were not. Color measurement was done using reflectance spectrophotometer based on the CIE L*a*b* color scale at baseline. All the specimens were immersed ice tea (Lipton Ice Tea, Turkey) and at the end of 1 and 7 days, color values were obtained again. After tea immersion procedure office bleaching was applied to all specimens and the color values were measured again. Analysis of variance and Bonferroni Correction were used for statistical analysis.

Results: Both resin composites showed color change after a period 1 to 7 days however no significant differences were found between 1 and 7 days immersion ($p>0.05$). Z550 exhibited significantly higher color change than GC Kalore ($p<0.05$).

Conclusion: The results of this study concluded that bleaching treatment did not caused any color change for both restorative groups. However the repeated bleaching procedure which was done following staining protocol had a favorable effect on the elimination of discoloration.

Keywords: *bleaching, resin composite, color, discoloration*

ÖZET

Amaç: Bu çalışmanın amacı beyazlatma tedavisinin iki farklı rezin kompozitin renklenmesi üzerine etkisini değerlendirmektir.

Gereç ve Yöntem: GC Kalore (GC Dental, Tokyo, Japan) ve Filtek Z550 (3M ESPE, Seefeld, Germany) kullanılarak yirmidört adet örnek hazırlanmıştır. Örneklerin on iki tanesine ofis tipi beyazlatma (Perfection White, Premier Dental, USA) yapılırken, kalan on iki örneğe yapılmamıştır. Spektrofotometre kullanılarak CIE L*a*b* renk aralığında başlangıç renk ölçümleri yapılmıştır. Tüm örnekler ice tea (Lipton Ice Tea, Turkey) içinde bekletilmiş, 1. ve 7. gün sonunda renk değerleri tekrar elde edilmiştir. Çayda bekletme prosedürü sonunda tüm örneklere ev tipi beyazlatma uygulaması yapılarak renk ölçümü yapılmıştır. İstatiksel analiz için Varyans analizi ve Bonferroni düzeltmesi kullanılmıştır.

Bulgular: Her iki rezin kompozitte 1. ve 7. gün sonunda renk değişimi olmuştur fakat 1. ve 7. gün yapılan ölçümler arasında istatiksel olarak anlamlı bir farklılık yoktur ($p>0.05$). Z550'nin renk değişimi GC Kalore'den istatiksel olarak anlamlı derecede yüksektir. ($p<0.05$).

Sonuç: Bu çalışmanın sonuçları ev tipi beyazlatma tedavisinin her iki restoratif grubunda renk değişimine etkisi olmadığını göstermiştir. Fakat renklenme sonrası tekrarlanan beyazlatmanın renklenmesinin giderilmesine olumlu etkisi olmuştur.

Anahtar Kelimeler: *beyazlatma, rezin kompozit, renk, renklenme*

[1] *Istanbul Medipol University Faculty of Dentistry, Department of Restorative Dentistry, İstanbul.*
[2] *Istanbul Medipol University, Faculty of Dentistry Department of Restorative Dentistry, İstanbul.*
[3] *Inonu University, Faculty of Medicine, Department of Biostatistics, Malatya.*

INTRODUCTION

Advancements in adhesive dentistry have resulted in the development of resin based composite materials which are most commonly used anterior esthetic restorative materials in contemporary dentistry. During the last two decades, the use of resin composites for aesthetic restorative procedures has increased. For anterior teeth, direct laminate veneer applications with resin composites are usually quick, inexpensive and easy to repair compared to ceramic veneers and they can provide acceptable esthetic results.[1] Esthetic restorative materials must simulate the natural tooth in color, translucency and texture.

However, a major disadvantage of these materials is discoloration after prolonged exposure to the oral environment. Resin composites undergo a series of physical changes as a result of the polymerization reaction and the subsequent interaction with the oral environment.[2] Discoloration is a multifactorial phenomenon and can be caused by intrinsic and extrinsic factors. Intrinsic factors involve the discoloration of the resin material itself, it is permanent and related to polymer quality, type, quantity of inorganic filler and the type of accelerator added to photoinitator system.[3] The intrinsic color of esthetic materials may change when materials are aged under various physical-chemical conditions such as thermal changes and humidity.[4] Extrinsic staining depends on the individual's diet, hygiene, and the chemical properties of the composite.[5] The discoloration is mainly caused by colorants contained in beverages and foods through adsorption and absorption. Several studies *in vitro* have demonstrated that common drinks and food ingredients, such as coffee, tea or red wine,[6] fruit juices,[7] cola drinks[8] could cause significant change in surface color of the composite resin materials. Extrinsic discoloration is an important factor affecting the color stability and long term success of composite resin restorations, which highlights the needs for dental researchers and material scientists to improve the resistance to discoloration of new resin-based materials for esthetic restorations.

Tooth bleaching is popular procedures that can be prone to overuse in an attempt to achieve a whiter tooth color. Dentists are experiencing an increased demand for tooth bleaching from patients. This demand has led to bleaching systems, such as vital tooth bleaching that can be done in the office by the clinician using high concentrations of hydrogen peroxide or a different treatment done at home by the patient with lower concentrations of carbamide peroxide. During the bleaching treatment, not only do these materials contact teeth but also restorative materials for extended periods of time. As discoloration of resin based composites is a common problem, studies also investigated the effect of bleaching agents on surface micro hardness, roughness, and color stability of adhesive restorative materials.[3,9,10] The initial color match of a light-polymerized restoration may be established however it could be changed. Long-term color changes could occur because of surface staining, marginal staining, micro leakage, wear-dependent surface changes, and internal material deterioration. Drastic color changes to existing restorations may compromise esthetics; therefore it is important to understand the effect of bleaching agents on the color of restorative materials. The purpose of this study was to evaluate the staining susceptibility and color stability of two resin composite bleached with 35% hydrogen peroxide office bleaching agent. The null

hypothesis of the study was that bleaching did not have a favorable effect on the color differences of stained resin composites.

MATERIAL AND METHODS

Restorative Materials, Staining Agent and Bleaching System

Restorative materials to be evaluated for their color stability were namely: a nano-sized hybrid resin composite with new monomer technology from DuPont (GC Kalore, GC Dental, Tokyo, Japan) and a nanohybrid universal resin composite (Filtek Z550, 3M ESPE, Seefeld, Germany). Ice Tea (Lipton Ice Tea, Turkey) was served as the staining agent. An in-office 35% hydrogen peroxide bleaching agent (Perfection White, Premier, USA) was used for bleaching treatment. Other details concerning the materials used in this study (e.g., composition and lot number) were listed in Table 1.

Specimen Preparation

Twenty four specimens were prepared for two restorative materials using teflon molds (5 mm in diameter and 2 mm thickness) and placed on a glass plate with Mylar strip. The moulds containing slightly over filled composite resins were covered by a second mylar strip and glass plate. Finger pressure was applied to the covering glass plate to expel excess materials and create a smooth surface. The resin composites were then polymerized in a LED light curing unit (Elipar Free Light, 3 M ESPE, AG, Germany, 1007 mW/cm^2) for 4 min to allow thorough polymerization. The discs were removed from the moulds, stored in distilled water for 24 h at 37^{0}C to ensure complete polymerization. Afterward, all the specimens were polished with Sof-Lex (3M ESPE, St. Paul, MN, USA) polishing discs in sequences of 4 from coarse to superfine using a slow-speed hand piece under dry conditions for 30 s. After each polishing step, the specimens were thoroughly rinsed with water for 10 s to remove debris, air dried for 5 s, and then polished with another disc of lower grit for the same period of time as a final polishing.

Table 1. *Characteristics of materials used in the study*

Materials		**Manufacturer** type	**Properties**		**Batch Number**
			content		
Resin composites	Filtek Z 550 (A2)	(Filtek Z 550 3M ESPE, Seefeld, Germany)	nanohybrid	BIS-GMA, UDMA, BIS-EMA, PEGDMA, TEGDMA	N286648
	GC Kalore (A2)	(GC Kalore, GC Dental, Tokyo, Japan)	nano-sized hybrid	Urethane Dimethacrylate (UDMA), Urethane Dimethacrylate (Dupont), Bisphenol A polyethoxymethacrylate, Camphorquinone	003578 1005141 2013-05
Bleaching system	Perfection White	(Perfection White, Premier, USA)	35% hydrogen peroxide bleaching agent		Pw 102510
Staining solution	Ice Tea	Lipton Ice Tea, Turkey	Tea served as cold		35-00010

Bleaching Process

The test protocol is shown in Figure 1. The specimens in each restorative material groups were divided into two groups according to receive bleaching or not (n=12). The specimens in one group of each restorative material were bleached with an office bleaching agent (Perfection White, Premier Dental, USA). One side of the specimens was coated with translucent nail polish. The bleaching agent was painted on the top surface of the specimen for 2 mm thickness according to the manufacturers' instructions at room temperature. The bleaching gel was leaved for 15 minutes on the specimens then rinse from the specimens. This procedure was applied four times then the specimens were rinsed with tap water for 1 minute to remove the bleaching agents, blotted dry, and stored in distilled water at 37^0C. A repeated bleaching was done for all specimens after 7 days immersion.

Staining Process

The specimens of each groups were individually immersed in 300 mL of Ice Tea (Lipton Ice Tea, Turkey) for 7 days at room temperature. The vials were sealed to prevent the evaporation of the solutions and the solutions were renewed daily.

Assessment of Color Change

Color measurement was done at baseline, after 1 and 7 days immersion and repeated bleaching using reflectance spectrophotometer (Vita Easyshade Compact, Vident, Canada) based on the CIE L*a*b* color scale against a white background. The color differences (ΔEab*) between the 4 measurements were calculated as follows:

ΔEab*=[(ΔL*)2+(Δa*)2+(Δb*)2]1/2

Where L* is lightness, a* is green-red (-a*=green; +a*=red), and b* is blue-yellow (-b*=blue; +b*=yellow).

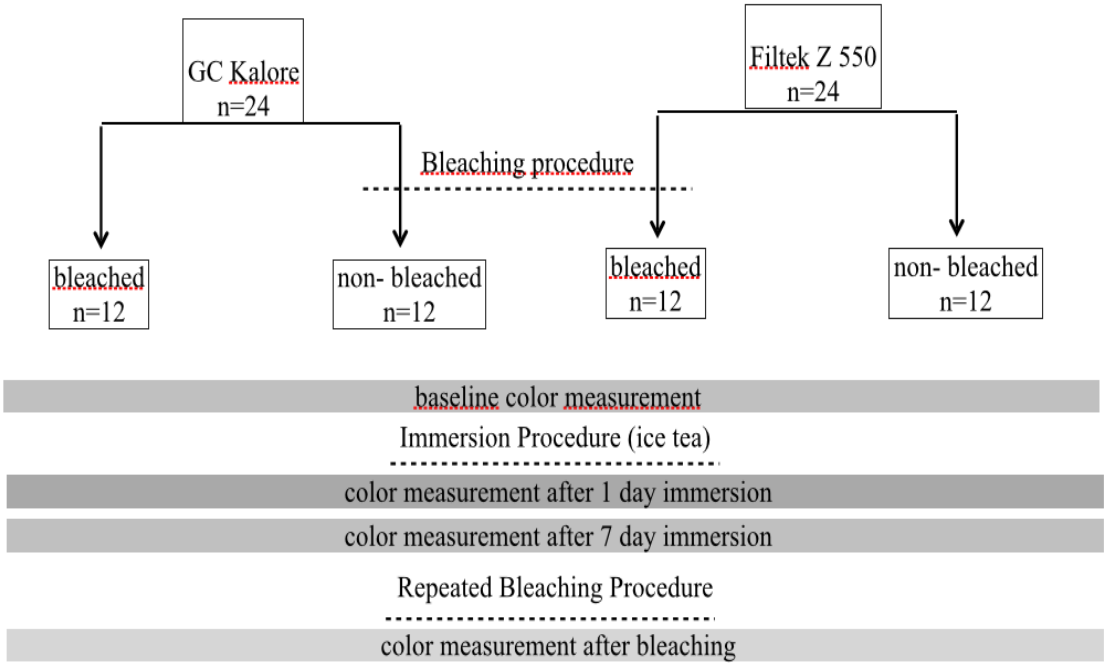

Figure 1. *Flow chart of the study*

Statistical analysis

A perceptible discoloration that is ΔEab * >1.0 will be referred to as acceptable up to the value ΔEab *= 3.3 in subjective visual evaluations made *in vitro* under optimal lighting conditions.[3] All comparisons of color change for bleaching and immersion periods were subjected to repeated measurements of analysis of variance ($p<0.05$) and the significant color changes (delta E*) occurred during immersion in different time intervals were tested with Bonferroni Correction.

RESULTS

Results of this *in vitro* study were summarized in Table 2. Bleaching treatment did not caused any color change for both restorative groups. Both resin composites showed color change after a period 1 to 7 days however no significant differences were found between 1 and 7 days immersion in staining solution ($p>0.05$). Z550 exhibited significantly higher color change than GC Kalore ($p<0.05$). Discoloration of the specimens after 1 and 7 days immersion in ice tea was recognized by naked eye. A limit of ΔEab * >3.3 was interpreted as a clinically acceptable difference in this study. Repeated bleaching procedure after the staining protocol had a favorable effect on the color differences of two resin composites.

DISCUSSION

Discoloration of composite resin remains a major cause for the esthetic failure of materials and this can be a reason for the replacement of restorations in esthetic areas. Once staining occurs, repolishing and bleaching procedures are presumed as whitening procedures can partially and totally remove stains.[11] Bleaching has become a routine treatment for improving esthetics. However, it is unavoidable to prevent restorations from bleaching agent exposure during bleaching treatments. Therefore, it was decided to investigate the effects of bleaching agents on the staining susceptibility of resin composites. As it had been mostly reported that bleaching increases the surface roughness of resin composites,[9,12,13] it might be expected that composite restorations would stain more easily after bleaching because rough surfaces mechanically tend to retain surface stains more than smoother surfaces.[14] Although, in the present study, bleached specimens showed similar color differences with non-bleached specimens groups after the immersion procedure.

According to Fontes et al[15] the pigmented layer of the composite (~40 mm) or the absorbed stains could theoretically be removed by polishing. Garoushi et al[11] was compared repolishing and bleaching procedures on the color differences of stained resin composites and observed a superior whitening effect with repolishing technique compared to bleaching. However, Fay et al[16] suggested that discoloration of resin composites can be partially removed by in-office bleaching and repolishing procedures. In the present *in vitro* study we had already observed that repeated bleaching procedure after the staining protocol had a favorable effect on the color differences of two resin composites. The discoloration observed after repeated bleaching procedures were higher 3.3 value which reported as threshold for the clinically unacceptable restorations. Thus the null hypothesis of the study was regretted.

Visual color assessment is a combination of physiological and psychological responses to radiant-energy stimulation. Alterations in perception can occur as a result of a number of uncontrolled factors, such as fatigue, aging, emotions, lighting conditions and

metamerism.[17] The use of spectrophotometers and colorimeters to quantify tooth color could potentially eliminate the subjective aspects of color assessment. In our laboratory study we used spectrophotometer (Vita Easyshade Compact, Vident, Canada) based on the CIE L*a*b* to assess the color differences. The ΔE value represents relative color changes that an observer might report when evaluating adhesive restorative materials. In dentistry, it has been reported that value ΔEab* of 3.3 is the critical value for visual perception.[18] In our *in vitro* observation it was found that after immersion in staining solution procedures, majority of tested groups had perceptible color changes (ΔEab* between 2,44 and 12,83). It could also been concluded that ice tea had a visually perceptible staining effect on GC Kalore and Filtek Z550 specimens.

It was revealed in the literature that the amount of color change of resin composites after bleaching procedures may be related to the materials' matrix content, filler type, and volume.[12] According to the data of our investigation, GC Kalore specimens showed higher ΔEab* than Filtek Z 550. The nanoybrid resin composite Filtek Z 550 includes bisphenol A-glycidyl methacrylate Bis-GMA in addition to the monomer Urethane Dimethacrylate (UDMA) that provides higher resistance to staining susceptibility. The lower ΔEab * values of GC Kalore also could be related to the monomer ingredient UDMA with a new monomer technology from DuPont.

There were some limitations in the current study that should be noted. Undoubtedly, 1 and 7 days of exposure periods could be highly unlikely to be reached during the normal consumption of beverages. Under clinical conditions, the pattern of staining solutions on restorative materials may be different. The other limitation is the lack of the determination of possible color mismatch on teeth restored with composites. Because teeth also become lighter and brighter as a result of bleaching, spectrophotometric evaluation of teeth restored with composites is indicated to gain more insight into the clinical relevance of color changes of these restoratives. In the present study it could be thought that bleaching procedures bleach the specimens instead of only removing the exterior staining from resin composites. It could be also revealed similar with an another literature that after bleaching, the composite resin restoration may not match the surrounding bleached tooth structure.[19] In addition to these we only evaluated just A2 shades of both materials; thus, the results may not be applicable to other shades.

CONCLUSIONS

Within the limitations of this *in vitro* study the following conclusions were drawn.

1) Bleaching procedures did not affect the staining susceptibility of two tested resin composites.

2) The UDMA monomer ingredient could lead the lower staining of nano hybrid resin composite tested.

3) Repeated bleaching procedures could be accepted as an alternative solution just for external staining of resin composites and patients should be advised that existing composite restorations may not match the natural teeth after bleaching, and replacement may be required.

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The Effect of Smoking on Postoperative Period of Extraction of Impacted Mandibular Third Molars

Seda YILMAZ[1], Hatice HOŞGÖR[2], Özlem Akbelen KAYA[3], Burcu BAŞ[4], Bora ÖZDEN[4]

ABSTRACT

Objective: The aim of this study was to evaluate the effect of cigarette smoking on the post-operative severity of pain, swelling and limitation of mouth opening after impacted mandibular third molar surgery.

Materials and Methods: This prospective comparative study was conducted for 147 cases in two groups of patients, smokers (n=31) and non-smokers (n= 116) who undergoes surgical extractions of impacted third molars. The patients' pre- and intra-operative findings of the study group were recorded. The patients were asked to fill out a form to record the findings of postoperative pain, swelling and mouth opening limitation for 6 days. Pain was recorded on a visual analog scale from 1 to 10 and swelling was recorded as mild, moderate and severe. The limitation of mouth opening was evaluated by the patient during the postoperative 6 days and was recorded as yes or no. One way ANOVA with f= 1;145 significance level was used as statistical analysis.

Results: The mean age of the smokers was 27,75±9,15 (20-55) while non-smokers was 25,7±6,9 (20-55). No significant difference was found at the post-operative period regarding the severity of pain, swelling and mouth opening.

Conclusion: Smoking did not considerably made difference in terms of postoperative symptoms followed by third molar surgery. However further studies need to be conducted with including larger sample size.

Keywords: *smoking, tooth extraction, third molars, pain, post-operative*

ÖZET

Amaç: Bu çalışmanın amacı sigara kullanımının gömülü diş çekiminden sonra ağrı, şişlik ve ağız açıklığında kısıtlılığa etkisinin değerlendirilmesidir.

Gereç ve Yöntem: Bu prospektif çalışmada cerrahi olarak gömülü 3. Molar diş çekimi yapılacak 147 hasta sigara içen (n=31) ve sigara içmeyen (n= 116) olarak iki gruba ayrılmıştır. Hastaların operasyon öncesi ve operasyonla ilgili bilgileri kaydedilmiş ve hastalardan operasyon sonrasında 6 gün süre ile şişlik, ağrı ve ağız açıklıklarında kısıtlılığı kaydedecekleri bir form doldurmaları istenmiştir. Ağrı Görsel Analog Skala ile 1-10 arasında, şişlik az orta ve şiddetli olarak, değerlendirilmiştir. Ağız açıklığındaki kısıtlılık hastalar tarafından değerlendirilmiş ve evet/hayır olarak kaydedilmiştir. İstatistiksel olarak f= 1;145 hata düzeyinde Tek-Yönlü ANOVA kullanılmıştır.

Sonuçlar: Sigara içen hastaların ortalama yaşı 27,75±9,15 (20-55), sigara içmeyenlerin 25,7±6,9 (20-55)'dır. Sigara içen ve içmeyen grupta operasyon sonrası dönemde ağrı, şişlik ve ağız açıklığında kısıtlılık açısından anlamlı bir farklılık saptanmamıştır.

Sonuç: Üçüncü molar cerrahisi sonrası sigara içilmesi ile semptomlar arasında herhangi anlamlı bir ilişki yoktur. Ancak, örneklem büyüklüğü geniş olan daha ileri çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: *sigara, diş çekimi, üçüncü molar dişler, ağrı, operasyon sonrası*

1 Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, İstanbul Aydın University, İstanbul, Turkey

2 Private Clinic, Kocaeli, Turkey

3 Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ondokuz Mayıs University, Samsun, Turkey

4 Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ondokuz Mayıs University, Samsun, Turkey

INTRODUCTION

Lower third molar extraction is one of the most common surgical procedure in oral surgery practice. Several authors have described different patient and surgery related factors that may influence the postoperative course of patients.[1-4] The age of the patient, cigarette smoking, bad oral hygiene and oral contraceptive use at the time of surgery are some of the patient related factors affecting outcome in third molar surgery.[5]

Smoking exerts a series of systemic effects upon the heart, blood vessels, central nervous system and endocrine glands, reducing pulmonary capacity and inducing peripheral vasoconstriction. It has also been associated with birth defects and fetal complications.[6] Among these general actions, fibrinolytic activity has been shown to decrease in smokers compared with nonsmokers, with a delay in wound healing.[7] Smoking exerts a negative influence upon wound healing, since it has been shown to impair polymorphonuclear cell function.[8]

In addition, it has been suggested that the vasoconstrictor effect of nicotine reduces the alveolar blood supply and increases pain.[9]
Removal of third molars is predictably associated with postoperative pain and swelling of variable duration, which delay return to normal activities. Several studies have evaluated the influence of oral hygiene and smoking on the post-operative period of third molar surgery.[1,4,5] Some investigators reported more pain in smokers after the extraction of third molars[10] ; however, others found no relationship between smoking and pain and swelling.[11,12] Al-Belasy[13] found that an increased smoking frequency and smoking on the day of surgery significantly increased the incidence of dry socket.

The objective of the present study was to evaluate the effect of cigarette smoking on the postoperative severity of pain, swelling and limitation of mouth opening after impacted mandibular third molar surgery.

MATERIALS AND METHODS

The experiment protocol of this study was approved by the Ethical Committee of Clinical Research of Ondokuz Mayıs University. This prospective comparative study was performed in two separate centers from September 2013 to January 2014 obtained from the patients referred A total of 147 cases, referred to the centers for management of impacted third molars, included to the study as smokers (n=31), and non-smokers (n=116). The smokers group consist of who smokes twenty or more per day.

The following inclusion and exclusion criteria were applied.
Inclusion criteria:

- Healthy volunteers over age 18 years and requiring surgical third molar extraction
- Absence of systemic disease (ASA I)
- The patients who had no difficulties in understanding and following through with the study
- The impacted third molars without any signs of infection

Exclusion criteria:

- Volunteers with systemic pathology
- Patients who could not fill out the forms
- Patients who had a limited intelligence, some physiological disorder or mental condition and had difficulties in language comprehension.

Before all operations, panoramic radiograph examinations were carried out to assess the anatomical structures adjacent to the third

molars, and the patients' pre- and intra-operative findings were recorded. Only one tooth was removed at each operation and all teeth were completely impacted. The position of impacted mandibular third molars were classified as Winter's classification (Table 1).

Table 1. *The classification of third molars included the study.*

WINTER'S CLASSIFICATION	SMOKERS (N = 31)	NON-SMOKERS (N = 116)
Vertical position	42%	52%
Mesioangular position	35%	40%
Distoangular position	6%	3%
Horizontal position	16%	6%

A total of three surgeons with more than 5 years' dentoalveolar training, assisted by training surgeons, performed the surgeries. Any preoperative medication was given. Each patient had similar surgical procedures, in the similar operating room and under similar conditions, using mepivacaine 2% with epinephrine 1:100.000 as local anesthetic (2% Carbocaine; AstraZeneca, Milan, Italy). No concomitant medication was used during surgery other than the local anesthetic. Access to the third molars was achieved from the buccal aspect and the bone was removed with a round burr in a straight hand piece under continuous irrigation with sterile saline solution. If necessary, sectioning of crown and

Figure 1. *The required form of postoperative findings.*

roots was performed with a fissure burr. After tooth extraction, the alveolus was inspected, curetted for granulation tissue removal, and irrigated with sterile saline solution. A 4/0 silk suture was used to close the wound without tension. Immediately after the operation, details of the procedure were recorded, including the duration of surgery in minutes (from the first incision to insertion of the last suture). An ice pack was then applied to the patient's face for 20 minutes. Postoperatively, amoxicillin and clavulonic acid combination (Augmentin BID 1000 mg) and flurbiprofen (Majezik 100 mg) every 12 hours twice per day were prescribed for all patients. All patients used the prescribed medications as ordered. Patients were instructed to rinse their mouth twice daily with 0.2% chlorhexidine mouthwash. The patients were asked to fill out a form to record the findings of postoperative pain, swelling and mouth opening limitation for 6 days (Figure 1). All patients returned at 7th day after the operation to have their sutures removed: the examiner was the same as the one who assessed them preoperatively. The patient's pain level were assessed with a 10-point visual analog scale anchored by the verbal descriptors "mild pain" (point 1) and "very severe pain (point 10). Patients were asked to enter their pain level and the time at which the analgesic was taken, and then make no further recordings. The limitation of mouth opening was evaluated by the patient during the postoperative 6 days and were recorded as yes (point 1) or no (point 0). The swelling also was evaluated by the patient's answer with a 3-point scale attached by the verbal descriptors 'mild', 'moderate' and 'severe'. The results were evaluated statistically and One way ANOVA with α=0.05 significance level was used as statistical analysis.

RESULTS

The 147 subjects were included to the study. Of these; 21,088 % were smokers and 78,911% were nonsmokers. The mean age of the smokers was 27,75±9,15 (20-55) and non-smokers 25,7±6,9 (20-55). No significant differences of age was recorded between smokers and nonsmokers (*f*=1,698). Table 2 presents postoperative pain intensity, facial swelling and limitation of mouth opening on post-operative days in both groups. The greatest pain levels appeared at 12 and 24 hours post-operatively in both groups. The rate of pain was greater in smokers than nonsmokers in all days during a week. However there was not a significant difference between two groups' pain score (*f*= 0,614). The swelling increased progressively after surgery, reaching a maximum at 24 hours. Between two groups there was no statistically significant difference of the swelling during the post-operative first week (*f*=1,297). When the two groups were compared, mouth opening values were similar to swelling and pain scores. The significant difference between smokers and nonsmokers were recorded in pain values (*f*=0,015). The severity of pain, swelling measurement and limitation of mouth opening in smoking group were higher than the non-smoking group.

DISCUSSION

It has been scientifically and medically proven that smoking is the cause of different crucial, deadly illnesses and diseases[14,15] among them tooth decay.[16,17] In addition, the tobacco use is known to impair wound healing.[18] Researches were shown that smokers are more likely to suffer complications during and following general surgery.[19,20]

In relation to its local effects, smoking has been described as an etiological factor in different oral disorders such as potentially cancerous

Table 2. *The statistical analyses of groups with regard to postoperative pain, swelling and limitation of mouth opening of patients.*

	1st day		2nd day		3rd day		4th day		5th day		6th day	
	Smoker (N = 31)	Non-smoker (N = 116)	Smoker (N = 31)	Non-smoker (N = 116)	Smoker (N = 31)	Non-smoker (N = 116)	Smoker (N = 31)	Non-smoker (N = 116)	Smoker (N = 31)	Non-smoker (N = 116)	Smoker (N = 31)	Non-smoker (N = 116)
PAIN (VAS)	6,06 ± 2,93	5,48 ± 2,77	4,35 ± 2,81	4,32 ± 2,71	3,58 ± 2,42	3,46 ± 2,28	2,94 ± 2,61	2,66 ± 2,14	2,10 ± 2,39	1,78 ± 1,92	1,61 ± 2,25	1,34 ± 1,86
f value (1;145)	1,048<3,91 / p< 0,05		0,004<3,91 / p< 0,05		0,070<3,91 / p< 0,05		0,382<3,91 / p< 0,05		0,614<3,91 / p< 0,05		0,493<3,91 / p< 0,05	
SWELLING	1,84 ± 0,82	1,72 ± 0,78	1,65 ± 0,91	1,72 ± 0,81	1,55 ± 0,89	1,49 ± 0,82	1,06 ± 0,81	1,21 ±0,73	0,94 ± 0,73	0,93 ± 0,63	0,68 ± 0,54	0,80 ± 0,55
f value (1;145)	0,519<3,91 / p< 0,05		0,220<3,91 / p< 0,05		0,114<3,91 / p< 0,05		0,883<3,91 / p< 0,05		0,001<3,91 / p< 0,05		1,297<3,91 / p< 0,05	
TRISMUS	0,81± 0,40	0,78 ±0,42	0,76 ±0,43	0,76 ± 0,43	0,74 ± 0,44	0,73 ± 0,44	0,58±0,50	0,59 ± 0,49	0,39 ± 0,50	0,38 ± 0,49	0,29 ±0,46	0,30 ± 0,46
f value(1;145)	0,133<3,91 / p< 0,05		0,032<3,91 / p< 0,05		0,010<3,91 / p< 0,05		0,003<3,91 / p< 0,05		0,006<3,91 / p< 0,05		0,015<3,91 / p< 0,05	

lesions and oral cancer. Smokers have a higher prevalence of leukoplakia than nonsmokers, with a positive dose-response relation. Cases of leukoplakia with areas of erythroplakia or associated with Candida infection are more frequent among smokers, and an increased risk of malignant transformation has been reported in such situations – with a direct relationship between dose and exposure time.[16]

Squamous cell carcinoma (SCC) is the most common oral malignancy, representing over 90% of all cases. Oliver et al., in 92 cases of SCC, found smoking to be the most relevant etiological factor (80% of the affected patients were smokers). [17]

Studies have been made of many effects of tobacco smoke upon different cell types. In this sense, Pabst et al.[21] have found smoking to produce deleterious effects upon the host immune system, including neutrophil and macrophage function. In effect, nicotine affects the phagocytic activity of these cells, thereby increasing the risk of bacterial colonization.[22] Based on the above effects and considering that smoking can affect local vascularization, the host defense mechanisms and cell lines, it may be postulated that such actions could have some extent influence the postoperative course of patients subjected to oral surgery. On the other hand, although lower third molar surgery is one of the most frequent interventions in oral surgery, the relationship between tobacco smoking and the postoperative complications in such patients has not been sufficiently investigated to date.

The surgical removal of impacted third molar is the daily procedure that is performed by oral and maxillofacial surgeons which involve many post-operative complications, the most common postoperative signs and symptoms of complications are pain, swelling and trismus.[23] Although many articles have been published on the effect of smoking on dry socket, smoking as a risk factor for the pain, swelling and trismus is still a debatable issue. [24-27]

In some studies, smoking was associated with an increase in postoperative pain after exodontias, and was more intense in heavy smokers (more than 20 cigarettes daily).[10,28,29] It has been suggested that the vasoconstrictor effect of nicotine reduces the alveolar blood supply and increases pain.[7] Capuzzi et al found no significant influence of smoking on postoperative pain and swelling after impacted third molar surgery.[12] There is currently no consensus regarding the postoperative healing after third molar surgery and smoking. In our study, no statistically significant differences have been recorded in terms of pain, swelling

and limitation of mouth opening after surgical removal of lower third molar. Our results were in accordance with the previous report of Carriches et al. who concluded that smoking did not influence wound condition and postoperative symptoms.[30] The limitations of this study was not to evaluate the relationship between the degree of smoking and postoperative findings. The subjective symptoms were considered to evaluate postoperative symptoms. Although we found no correlation between smoking and postoperative symptoms of third molar surgery, we strongly suggest further studies including larger samples. Different results may be found if only heavy smokers include to the studies.

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The Closure Screw Loosening Complication of Single-Molar Implant Mimicking Peri-Implant Mucositis: A Case Report

Sibel DİKİCİER[1], Emre DİKİCİER[2], Jülide ÖZEN[3]

ABSTRACT

Screw complications may not lead to implant failures, but they are significant in relation to the amount of repair needed, time, and cost to both the clinician and patient in private practice. For submerged healing, the closure screws are particularly recommended in dental implant procedures. However screw loosening occurs after the placement of dental implants continuously over time as a result of fatigue, stress or inadequate torque. The purpose of this case report is to evaluate the closure screw loosening complication the single-molar peri-implant mucosa mimicking peri-implant mucositis. A 38-year-old male presented with swelling and suppuration around left mandibular single-molar implants 4 weeks after implant placement. A radiograph indicated that the closure screw loosening occurred, the implant had not peri-implant bone loss. After the surgical removal of the closure screw, a healing cap was placed. The symptoms reduced after treatment. At the 6-month follow-up, there were no mechanical or biological complications.

Keywords: *dental implant; screw loosening; peri-implant mucositis*

ÖZET

Vida komplikasyonları; implant kayıplarına sebep olmayabilir, ancak, pratikte hekime ve hastaya düzeltme ihtiyacı gerektirerek, zaman ve maliyet kaybı yaratabilir. Dental implant prosedürlerinde, kapalı iyileşme için özellikle kapama vidası kullanımı önerilir. Bununla beraber; implant yerleştirildikten sonra, yorgunluk, stres veya yetersiz sıkma gibi nedenlerden dolayı vida gevşemesi meydana gelebilir. Bu olgu sunumunun amacı; kapama vidasının gevşemesi nedeniyle tek diş implant etrafındaki mukozada peri-implant mukozitisi andıran bir komplikasyonun değerlendirilmesidir. 38 yaşındaki erkek hastada; implant yerleştirilmesinden sonraki 4. haftada, sol mandibular tek diş molar implant etrafında şiş ve enfeksiyon mevcuttu. Radyografik değerlendirmede, kapama vidasının gevşediği gözlendi, implant etrafında kemik kaybı yoktu. Kapama vidası cerrahi olarak çıkartıldı, iyileşme başlığı yerleştirildi. Tedavi sonrası semptomlarda azalma görüldü. 6 aylık takipte; herhangi bir mekanik veya biyolojik komplikasyon gözlenmedi.

Anahtar Kelimeler: *dental implant; vida gevşemesi; peri-implant mukozitis*

[1] *Corlu Military Hospital, Department of Prosthodontics, Tekirdag, Turkey*
[2] *Corlu Military Hospital, Department of Oral and Maxillofacial Surgery, Tekirdag, Turkey*
[3] *Istanbul Aydın University, Department of Prosthodontics, Istanbul, Turkey*

INTRODUCTION

With the advance of dental implant technology and the consequential increase in its success rate, the dental implant has become a highly predictable treatment method. Despite this, related complications are on the rise, with peri-implant mucositis and peri-implantitis being the most commonly observed.[1] The failure of dental implants is due not only to this biological factors, but may also result from technical complications such as screw fracture and screw loosening during the treatment procedure.[2]

For submerged healing, the closure screws are particularly recommended in dental implant procedures. However screw loosening occurs after the placement of dental implants continuously over time as a result of fatigue, stress or inadequate torque.[3]

Peri-implant mucositis is defined as an inflammatory reaction of soft tissue around implants. Plaque accumulation has been established as etiological factor, smoking was identified as modifiable patient-related and excess cement as local risk indicator for the development of peri-implant mucositis.[4,5] This case report describes the management of an implant closure screw loosening of left mandibular single-molar implants mimicking peri-implant mucositis with minimal damage to the soft tissue.

CASE REPORT

A 38-year-old male was referred to our clinic for dental implant placement to restore the missing mandibular first molar. The medical and dental histories of the patient were thoroughly examined. Surgery was performed under local anesthesia and 4.0x11.5 mm osseointegrated implant were placed in missing first molar area. Approximately 4 weeks after surgery, the patient was returned with symptoms characterized by swelling, pain and inflammation on crestal mucosa of implant side (Figure 1). The closure screw loosening was occurred on the panoramic radiograph (Figure 2).

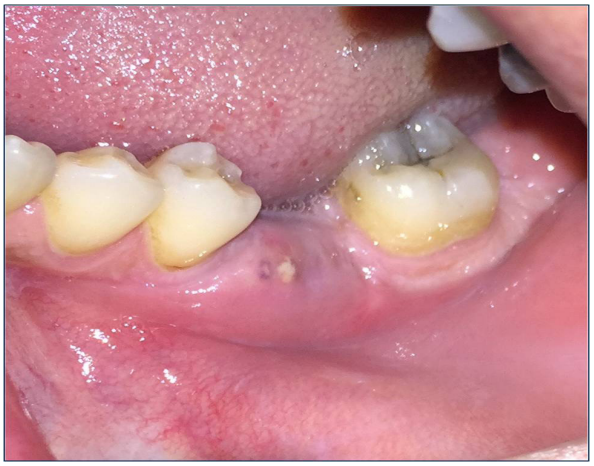

Figure 1. *Pre-operative intraoral view of the implant side*

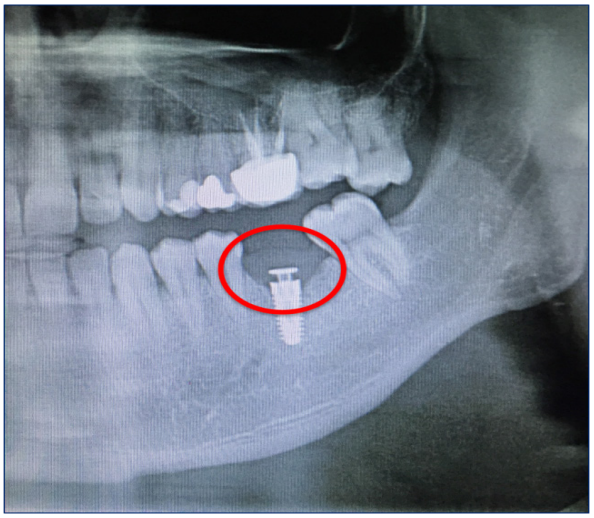

Figure 2. *Pre-operative view of the radiograph*

A crestal incision was made over the implant side, mobilized screw was removed and intraoral drainage was performed. After this procedure, a healing cap was placed and

incision was sutured. Medication therapy (Amoxicillin Clavulanate 1000 mg, Ibuprofen, Chlorhexidine gluconate) was started to resolution of the infection for seven days. The patient was completely asymptomatic during the healing period. Eight weeks later a panoramic radiography revealed a non-inflamed mucosa with no pathology evident. After the healing and osseointegration period of 2 months, implant retained single crown was finished (Figure 3-4). Follow-up period obtained five months later showed favorable results.

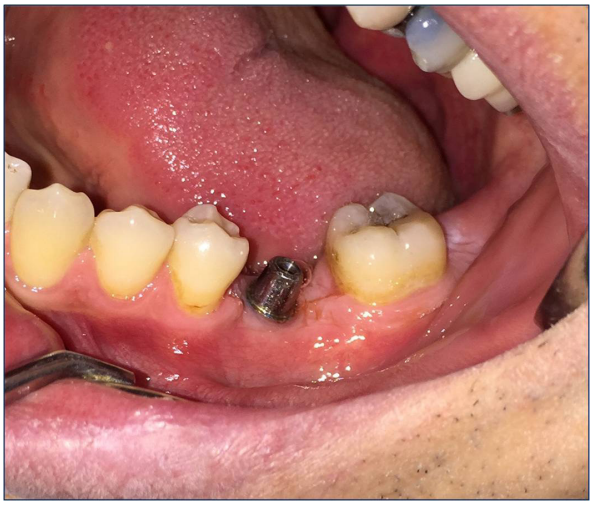

Figure 3. *Post-operative healing and implant abutment*

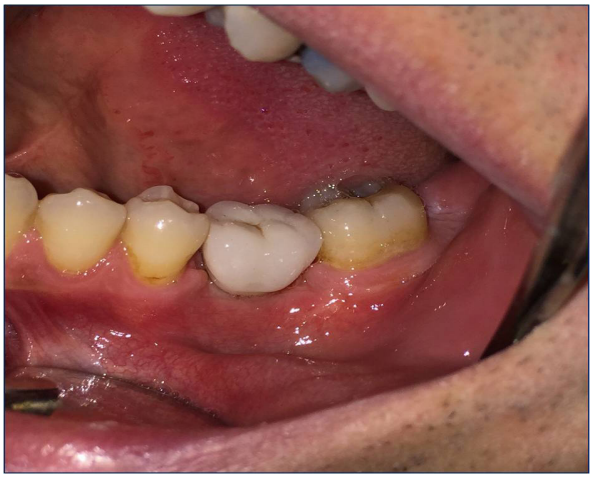

Figure 4. *Final prosthetic restoration*

DISCUSSION

Implant restorations can fail biologically or mechanically. Biological factors include unsuccessful osseointegration or presence of peri-implant mucositis and peri-implantitis. Mechanical failures include crown fracture, framework fracture, screw loosening, and screw fracture.[6] To minimize the frequency of complications, rules must be established from diagnosis to the completion of treatment and follow up of implant-supported rehabilitations, especially in terms of adequate technical steps and careful radiographic evaluation of the components.

Chae et al.[7] reported that biological complications were more frequent than mechanical complications in comparison between selected two implant systems. They also indicated that soft tissue complications had the highest incidence, followed by loosening or fracture of the abutment or screw, probing pocket depth>4 mm, and chipping of the veneering material.[7] Moreover, in the present case, soft tissue inflammation has been observed due to the screw loosening. Consequently, both biological and mechanical complications were observed at the same time.

Single implants and implant-supported single crowns have become popular treatment modalities for single tooth replacement. A recent study has identified high implant survival rates, but also many complications.[8] In this case, the closure screw had lost because of the biomechanical overload on mucosal site. In an attempt to rectify the pathology, screw was replaced and inflammation was healed, surgical debridement and antibiotic therapy were utilized before the prosthodontic procedure.

The 6th and 7th workshops of periodontology suggested the clinical definition of peri-implant mucositis as the presence of bleeding on probing without loss of supporting bone.[9,10] Despite of the similar symptoms, in the present case, the patient was not diagnosed with peri-implant mucositis. It was considered that closure screw loosening has lead the inflammation in soft tissue around the implant side.

This study confirmed that single tooth replacement using implant therapy had a high survival rate. However, pre-loading complications frequently occurred. Patients with dental implants require periodic examination and maintenance therapy to prevent peri-implant complications. The examination should include a periodontal, prosthetic, radiographic and occlusal evaluation. Not only in osseointegration process but also in prosthodontic loading process, there is a need for long-term studies evaluating the outcome of single dental implant rehabilitations.

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Oroantral Fistula Associated with Destructive Periodontitis

Feyza OTAN ÖZDEN[1], Bora ÖZDEN[2], H.İlyas KÖSE[2], Esra DEMİR[1], Peruze ÇELENK[3]

ABSTRACT

Background: Oroantral fistula (OAF) is a pathological communication between the oral cavity and maxillary sinus. This abnormal connection may be the result of a number of pathologic factors and often occurs following an extraction of posterior maxillary teeth due to the close anatomical relationship between the teeth and the sinus floor.

Objective: A rare case with maxillary sinusitis and advanced periodontitis that created oroantral fistula and its treatment with pedicled buccal fat pat was presented.

Case Description: Clinical and radiological examination of the 46-year-old male revealed OAF and Class II furcation involvement related with the tooth #17. The tooth was extracted and the buccal fat pad was stitched to the adjacent mucosa. Postoperative course was uneventful and the patient underwent periodontal therapy.

Practical implications: The maxillary sinus infection and/or periodontal destruction are rare causes of OAF. If these diseases are neglected or advanced, may lead to irreversible fistulas.

Keywords: *oroantral fistula, periodontitis, buccal fat pad*

ÖZET

Giriş: Oroantral fistül (OAF) oral kavite ve maksiller sinüs arasındaki patolojik bağlantıdır. Bu anormal bağlantı birçok patolojik faktör sonucu oluşabilir. Sıklıkla sinüs tabanıyla molar ve premolar dişlerin kök uçları arasındaki yakın anatomik ilişkiye bağlı olarak posterior maksiller dişin çekimini takiben oluşur.

Amaç: Bu makalede, nadir görülen maksiller sinüzit ve ilerlemiş periodontitis sonucu oluşan oroantral fistül ve fistülün saplı bukkal yağ dokusuyla tedavisi sunulmuştur.

Vaka: 46 yaşında erkek hastanın klinik ve radyografik muayenesinde 17 numaralı dişle ilişkili olarak sınıf II furkasyon problemi ile beraber oroantral fistül olduğu saptandı. Diş çekildi ve bukkal yağ dokusu komşu mukozaya dikildi. Postoperatif iyileşme sorunsuz tamamlandı ve hasta periodontal tedavi altına alındı.

Pratik Önem: Maksiller sinüs infeksiyonu ve/veya periodontal yıkım OAF'ye çok nadiren sebep olabilir. Bu hastalıklar ihmal edildiğinde veya ilerlediğinde geriye dönüşümsüz olarak fistüle neden olabilmektedir.

Anahtar Kelimeler: *oroantral fistül, periodontitis, bukkal yağ dokusu*

[1] *University of Ondokuz Mayis, Faculty of Dentistry, Department of Periodontology, Samsun, Turkey*
[2] *University of Ondokuz Mayis, Faculty of Dentistry, Department of Oral and Maxillofacial Surgery, Samsun, Turkey*
[3] *University of Ondokuz Mayis, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Samsun, Turkey*

INTRODUCTION

The maxillary sinus is the largest of the paranasal sinuses. It drains into the middle nasal meatus of the nasal cavity with single or multiple openings and there is not normally association with the oral cavity. Oroantral communication (OAC) is an abnormal pathway between the oral cavity and maxillary sinus. It commonly occurs as a complication of four upper last maxillary teeth extraction (80%), due to the anatomic proximity of the maxillary sinus to the dentoalveolar complex.[1] In addition, OAC may result as following; removal of the maxillary cyst (10-15%) and tumors (5-10%), trauma(2-5%),[1] osteomyelitis (11%)[2], Caldwell-Luc procedure (7.5%)[2] or dental implant placement.[3]An OAC less than 2 mm diameter can spontaneously close, whereas those larger than 3mm require surgical procedures. [4] If OAC is not treated,

the epithelial tissues may grow in it, leading to the fistula formation and it is called oroantral fistula (OAF). The OAF causes the passage of microflora from the oral cavity into the maxillary sinus via an epithelialized tract linking. In a rarely condition, periodontal infections were reported to lead OAF formations.[5-7] If there is an oroantral communication associated with periodontitis, intraoral radiographs or panoramic radiographs can be used for the evaluation of periodontal bone loss. In this situation, radiological observations might show a sinus floor discontinuity, sinus opacity, focal alveolar atrophy and associated periodontal disease.

In this paper, a rare case with maxillary sinusitis and advanced periodontitis that created OAF and its treatment with pedicled buccal fat pat was presented.

CASE REPORT

A 46-year-old male patient was referred to our clinic with complains of fluid passage going from mouth to nose when drinking and feeling a sensation of air rushing through the socket as he breathes since two years. The patient had chronic renal disease and was otherwise healthy.

Clinical examination revealed OAF 5mm above from the root apices and deep periodontal pockets deeper than ≥4 mm, at the interproximal and lingual sides of the tooth #17. Class II furcation involvement was also noted on the mesial side and root apex was visually seen (Fig.1a).

Periapical and panoramic radiographs revealed radiolucency at furcations and angular bony destructions at the interproximal sides of the tooth #17 and the buccal defect extended apically causing the OAF as seen also clinically (Fig.1a, Fig.2). Computed Tomography (CT) images belonging to the right maxillary sinus region revealed the presence of a persistently opacified sinus cavity and a severe mucosal thickening. The circumferential bony defect was observed around the apical one-third of the buccal root of the first molar in three-dimensional imaging. The osseous communication between the maxillary sinus and periodontal intrabony defects was also seen (Fig.3).

The patient was placed on Amoxicillin capsules (500mg 8hrly) three days before the surgery. Excision of the fistulous tract from the sinus to the oral cavity and freshening of the wound edges done after local anesthesia with 2% lignocaine with adrenaline 1:80,000 was achieved. A full-thickness mucoperiosteal flap was reflected and granulation tissue was carefully removed. Upon flap reflection a sinus

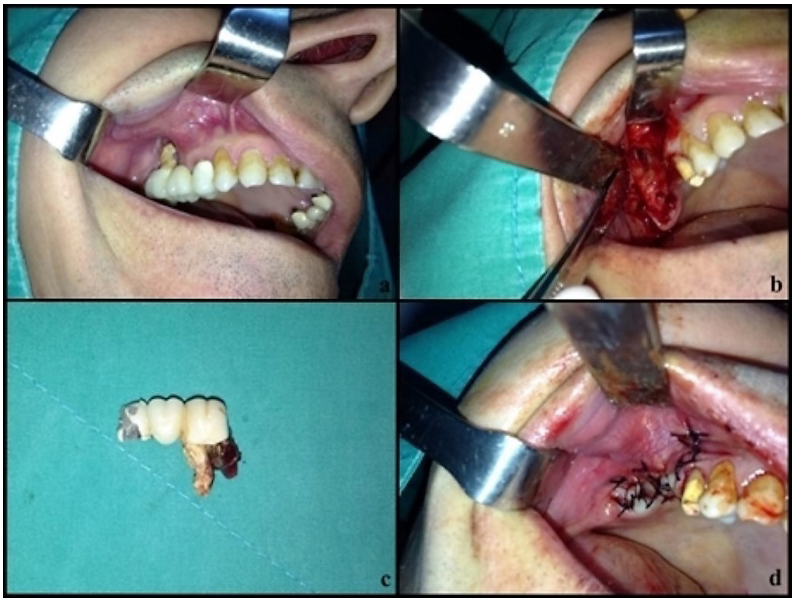

Figure 1. *a) Intraoral photograph showing OAF and periodontal defects, b) Harvesting of buccal fat pad (BFP), c) Extracted tooth with fixed prosthesis, d) Double-layered closure of OAC using BFP and buccal advancement flap.*

communication measuring 5mm in diameter was observed at the apex of the buccal root (Fig.1b). The second maxillary first molar was extracted (Fig.1c). The borders of the fistula were subperiosteally incised in wedge with superior extension in vestibular floor up to the inserted mucosa. The posterior superior elevation was done with an elevator, close to the maxillary wall until the buccal fat pad was found. The buccal fat pad was stitched to the adjacent mucosa with plain catgut 3.0 suture. (Fig. 1d) After the surgery, the patient was medicated and guided not to do any intra-oral negative pressure.

The histopathological examination revealed chronic sinusitis with presence of inflammatory cell infiltration and mucous glands. Postoperative course was uneventful and the patient underwent periodontal therapy including the whole mouth scaling and root planning. However, refusal of the patient for coming to the following treatments and the controls made the long term follow-up impossible.

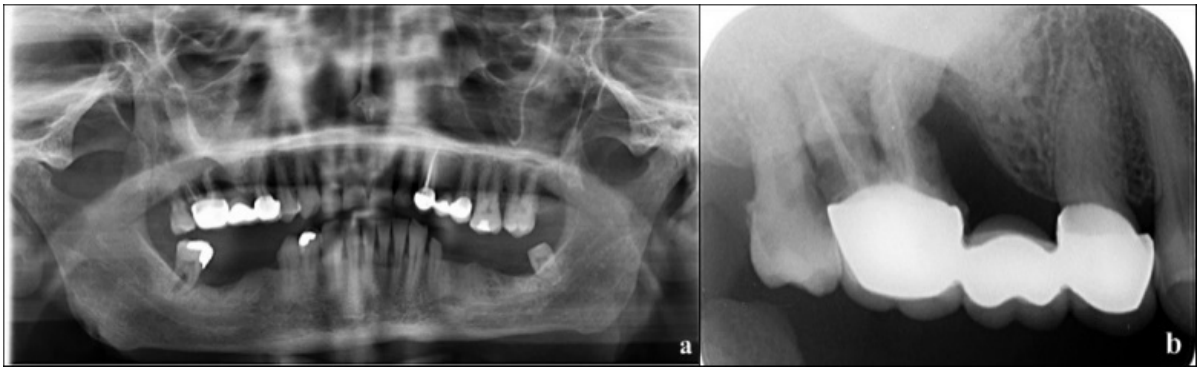

Figure 2. *a) Panoramic and b) periapical radiography showing horizontal and vertical bone defects.*

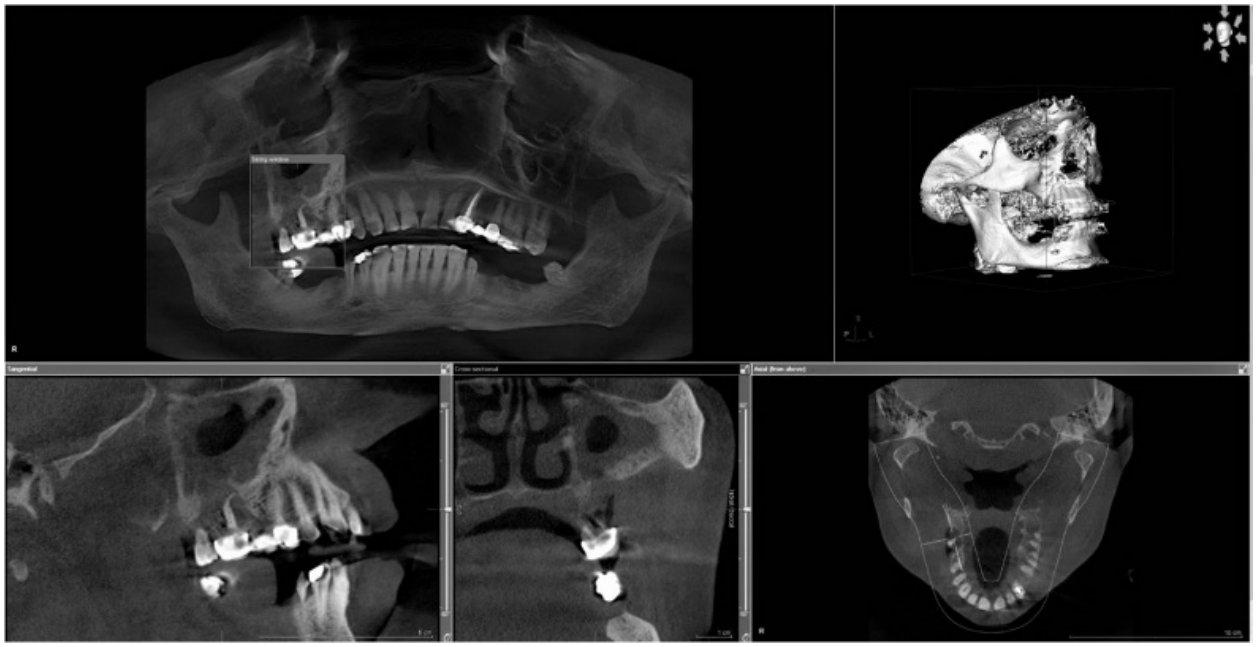

Figure 3. *The appearance of oroantral fistula on multiplanar CT imaging.*

DISCUSSION

Dental extractions, excision of the maxillary cyst and tumors, trauma, osteoradionecrosis or minor surgical procedures are the main causes of OAF.[1] The fistula might also very rarely originate following periodontal infections. However there exists limited information about the relation between periodontal problems and OAF. Franco-Carro et al. reported that only 0.93% of 1072 cases were originated from periodontal problems.[5] Logan and Coates reported a case with OAF as a result of a periodontal disease associated with HIV.[6] Moscow found that all 19 microscopic specimens demonstrated moderate to advanced periodontitis with significant pathologic changes in the mucosa of the maxillary sinus.[7] Periodontal diseases, which are chronic inflammatory disorders are localized to the attachment structures of the teeth, and considered to be the major cause of tooth loss in adults.[8] Thus the inflammatory process results in destruction of connective tissue and alveolar bone. As a result of this process, significant pathologic changes in the mucosa of the maxillary sinus may occur. Similar to the presented case, if both chronic sinusitis and destructive periodontitis of the infected tooth is present, it is very difficult to determine the main etiologic factor of the OAF. The treatment approach included first the control of sinusitis with antibiotics and then periodontal therapy applied.

Small fistulas tend to heal spontaneously, whereas larger fistulae rarely heal. Surgery is indicated if a fistula does not heal within three weeks.[4] Closing this communication is important to avoid food and saliva contamination that could lead to bacterial infection, impaired healing and chronic sinusitis. Various methods for the closure of communications have been reported in the literature, such as local flaps, distant flaps, grafts [2,4] and the buccal fat pad (BFP).[9] Each has advantages and disadvantages. The most common methods used today for closure of

OAF are buccal and palatal flaps. Borgonovo et al. advised buccal flap for small and mesial fistulas, taking into consideration that additional surgery to re-establish the proper vestibular depth may be necessary. [10]

The purpose of this article was to present a rare case with maxillary sinusitis and advanced periodontitis together that destroyed the lateral sinus wall and created OAF. The limitation of the presented case is the long term follow up of the patient who underwent periodontal therapy and closure of the OAF with buccal fat flap. Larger studies with long time intervals are necessary to reveal the success of this kind of therapy approach.

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Veillonella Spp. Infection As a Rare Cause for Early Multiple Dental Implant Failures: A Case Report

Mustafa TUNALI[1], Cenker Zeki KOYUNCUOGLU[2], Burak SELEK[3], Bayhan BEKTORE[3], Mustafa OZYURT[3], Rana ÇULHAOĞLU[4]

ABSTRACT

Background: Infection, overheating, premature loading and impaired healing are the main factors associated with early failure of dental implants. Multiple implant failures in the same patient, supports the evidence that individual characteristics play an important role in the early failure process. Veillonella spp. are early colonizers of dental biofilms and small, usually non-fermentative, strict anaerobic, nonmotile, nonsporulating, gram-negative cocci that lack capsule.

Objective: The objective of this study was to investigate the possible associated factors and early multiple implant failures in the same patient.

Case Description: A 55-years-old female patient had peri-implant radiolucencies of two adjacent implant sites at the left posterior mandibula 3 months after surgical placement. Aerobic and anaerobic culture techniques were used to study the peri-implant microflora at sites with implant failures. An amoxicillin-resistant Veillonella bacteria was isolated.

Conclusion: The present case shows that amoxicillin-resistant Veillonella associated peri-implantitis can be a risk factor for early implant failures.

Keywords: *Early failure, dental implant, risk factors, Veillonella*

ÖZET

Giriş: Enfeksiyon, aşırı ısınma, erken yükleme ve iyileşmenin bozulması dental implantların erken kayıpları ile ilişkili başlıca faktörlerdir. Aynı hastada birden çok implant kaybı bireysel özelliklerin erken başarısızlık sürecinde önemli bir rol oynadığı yönündeki delilleri kuvvetlendirmektedir. Veillonella dental biyofilmde erken kolonize olan türlerdendir ve küçük, sıklıkla fermentatif olmayan, zorunlu anaerob, hareketsiz, sporsuz, kapsülsüz gram-negatif koklardır.

Amaç: Bu çalışmanın amacı bir hastada meydana gelen çoklu implant kayıpları ile olası faktörler arasındaki ilişkiyi araştırmaktır.

Olgu Sunumu: 55 yaşında bayan hastanın alt çene sol posterior bölgesine yapılan implant operasyonlarından 3 ay sonra birbirine komşu 2 implant bölgesinde periimplant radyolusensi tespit edilmiştir. İmplant kaybı olan bölgelerde peri-implant mikroflora aerobik ve anaerobik kültür teknikleri ile çalışılmıştır. Amoksisiline dirençli Veilonella bakterisi izole edilmiştir.

Sonuç: Bu vaka raporuna göre amoksisiline dirençli Veilonella türlerine bağlı olarak gelişebilen periimplantitisin erken implant kayıpları için bir risk faktörü olabileceği gösterilmiştir.

Anahtar Kelimeler: *Erken kayıp, diş implantı, risk faktörleri, Veillonella*

[1] *Gulhane Military Medical Academy, Haydarpasa Hospital, Periodontology, Istanbul, Turkey.*
[2] *Istanbul Aydin University, Faculty of Dentistry, Department of Periodontology, Istanbul, Turkey.*
[3] *Gulhane Military Medical Academy, Haydarpasa Hospital, Medical Microbiology, Istanbul, Turkey.*
[4] *Gazi University, Faculty of Dentistry, Department of Periodontology, Ankara, Turkey*

INTRODUCTION

Today many conventionally prosthetic treatments have been replaced by implant supported prosthetic supraconstructions. Despite high success rates[1,2] implant fixture failure may occur and is defined as 'the inadequacy of the host tissue to establish or maintain osseointegration. Implant failure timing can be arbitrarily divided into early, when osseointegration fails to occur, and late, when the achieved osseointegration is lost after a period of function. The early failures described as implants removed before prosthetic restoration, while those occurring after prosthetic rehabilitation are classified as late[3]. The implant loss can be attributed to factors such as biological, microbiological, and biomechanical, but the cause and mechanism of the early implant failure are still obscure[4] and the reported early failure rate is from 0.7% to 3.8%.[5] Multiple implant failures in the same patient, supports the evidence that individual characteristics (genetics or microbiological), play a crucial role in the early failure process.[6] Some studies have analyzed the relationship between genetic polymorphisms of the host response and implant failure. Santos et al.[6] stated that the polymorphism in the promoter of the MMP-1 gene could be a risk factor for early implant failure. However, Rogers et al.[7] found no association between the IL-1 composite genotype and failure of dental implants. Also, other studies results indicate that polymorphisms in the IL-2, IL-6 [8] and transforming growth factor-β1[9] genes are not associated with early implant failure.

Infectious origin of early failures can be due to a preoperative contamination, an infected recipient site or a postoperative hematogeneous infection. Possible sources of direct bacterial contamination during implant surgery; the gloves, the surgical instruments, the peri-oral skin and saliva in the oral cavity.[10] Also, implants placed next to asymptomatic, endodontically treated teeth have been reported to be associated with greater failure due to infection.[11] Infection represents one of many factors contributing to the failure of dental implants and no single micro-organism has been closely associated with colonization or infection of any implant system.[12] The aim of this case report is to investigate the possible association between, an amoxicillin-resistant Veillonella spp. and the early multiple implant failures in the same patient.

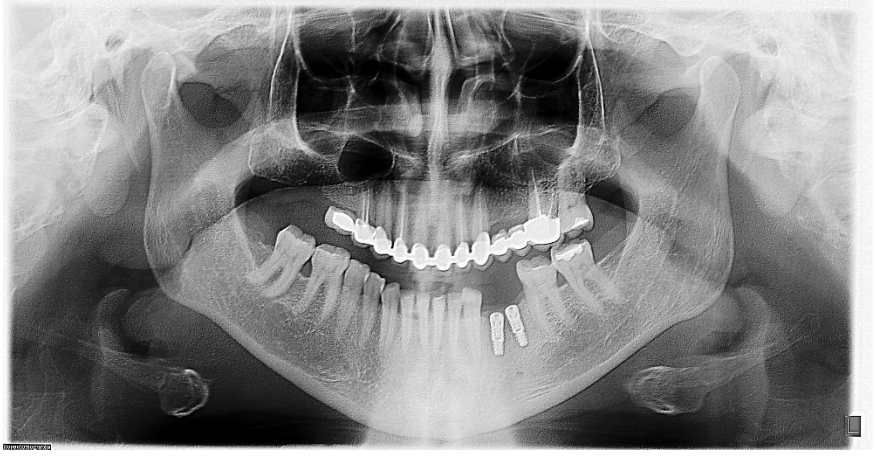

Figure 1. *Peri-implant radiolucencies of two adjacent implants 3 months after surgical placement.*

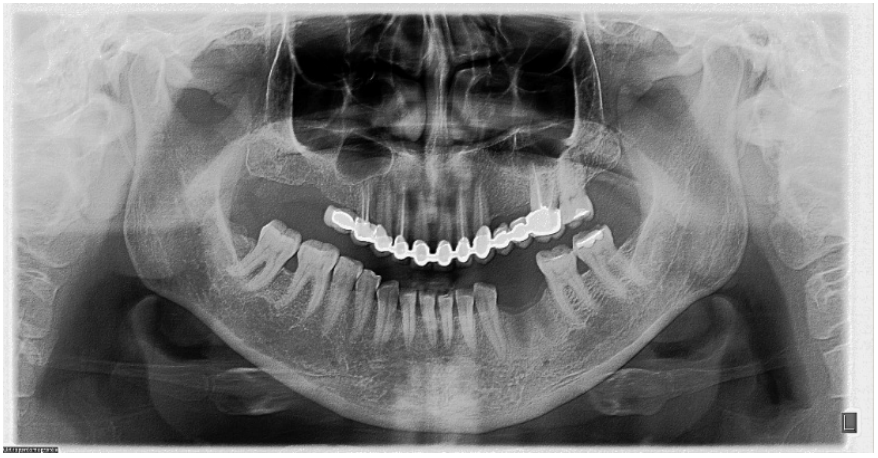

Figure 2. *No augmentation method was performed at the failed implant sites.*

CASE REPORT

A 55-years-old, non-smoking woman was referred for replacement of her missing mandibular left first and second premolars with an implant supported prosthesis. The patient's medical history was insignificant. Intraoral examination revealed localized mild periodontitis and the missing premolars had been lost due to crown fracture caries approximately 10 years ago. Treatment included scaling, root planning and oral hygiene instructions. The clinical signs of periodontitis were markedly improved at re-evaluation appointment. Two 3.75 × 10 mm titanium fixture (Biohorizon; Tapered Internal Implant System, Birmingham, USA) was placed in the edentulous area on the mandibular left side under local anesthesia. The implants replaced with 35 N and primary closure over the cover screw was obtained. Postoperative medication included; amoxicillin 500 mg 3 times daily and 0.12% chlorhexidine rinse 2 times daily, 1 week. The sutures was removed ten days after the surgery and the patient was seen at 3 weeks post-surgery for follow-up. The healing was uneventful at both visits and the cover screws were unexposed.

At 3 months after the implantation; there was no apparent soft tissue inflammation or infection. The patient had experienced no pain, and there were no signs of suppuration, fever, vestibular swelling, or lymphadenopathy. However, radiological examination revealed that patient had peri-implant radiolucencies both of the two implants (Figure 1). Failed osseointegration was seen after the full thickness flap was elevated and implants were surgically removed with tissue pliers. Aerobic and anaerobic culture techniques were used to study the peri-implant microflora at sites with implant failures. No augmentation procedure was utilized or guided bone regeneration was performed at the surgical site (Figure 2). Subsequent medical follow-up was performed to rule out systemic factors to the occurrence, but complete blood count and screening tests proved to be within normal parameters. An amoxicillin-resistant Veillonella bacteria was isolated at sites with early implant failures. Three months after implant failures a second operation was done. Patient who had amoxicillin-resistant Veillonella bacteria was given clindamycin 150 mg every 6 h for 5 days postoperatively. The implants were

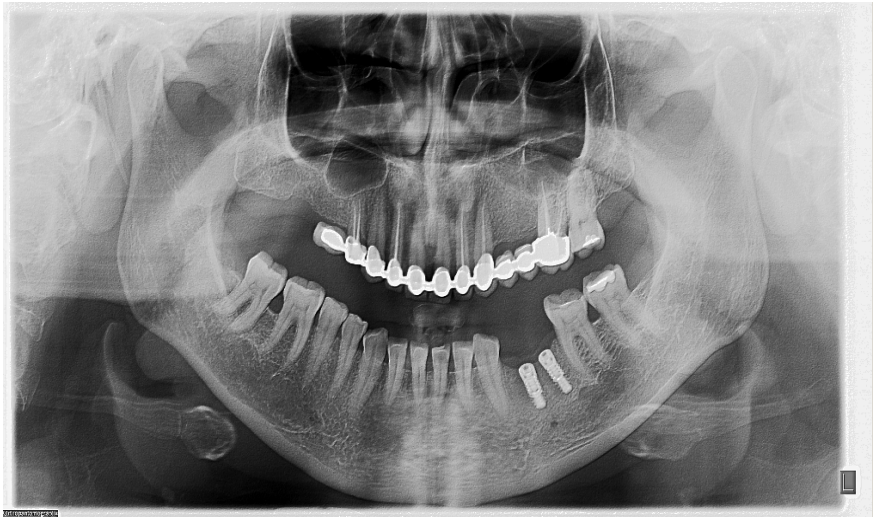

Figure 3. *Radiographic evaluation of two adjacent implants 3 months after second surgical placement.*

evaluated from the time of their placement (Figure 3) until six months after prosthetic treatment (Figure 4).

Microbiology

The implants taken out of the patient were incubated into regenerated tyogluconate medium and %5 sheep blood agar at the bed-side. Additionally and simultaneously, the aerobe cultures were also taken. The mediums were evaluated regarding anaerobe growth after they were incubated inside an anaerobe cabin (Bactron IV anaerobic chamber Sheldon Lab., USA) at 35-37 °C for at least 72 hours. Besides, aerobe growth was also evaluated after 24 hours of aerobe incubation. The identification of these growing species were made according to their gram dye, morphology of the colony, hemolysis characteristics, movement, catalase, indole, esculine, gelatin, urease, and oxidase tests and carbohydrate fermentation characteristics by conventional methods and automatic VITEK2 (bioMerieux, France) system. Penicillin (P), amoxicillin-clavulanate (AMC), meropeneme, clindamicin (DA) sensitivities were evaluated with E-test method.

DISCUSSION

Implant failures can be divided according to chronological criteria in early (primary) failures (failure to establish osseointegration) and late (secondary) failures (failure to maintain the established osseointegration)[3]. Early implant failure usually occurs very rapidly with progressive bone resorption and loss of the implant before loading. If this bone loss is not detected and treated at an early stage, implant failure will result.[13] Early implant failures occur because fibrous scar tissue is formed between the bone and implant surface postoperatively, instead of intimate bone-to-implant contact.[14] This type of failures have two different histopathological features, which may represent different phases of the failure process. In one of them, a dense connective tissue capsule rich in fibroblasts and collagen bundles aligned parallel to the implant surface, together with few inflammatory cells surrounding some of these implants. The other histopathological feature was characterized by a soft tissue capsule heavily infiltrated by a large number of inflammatory cells.[15]

Early failure of dental implants could be attributed to local or systemic factors.[16,17]

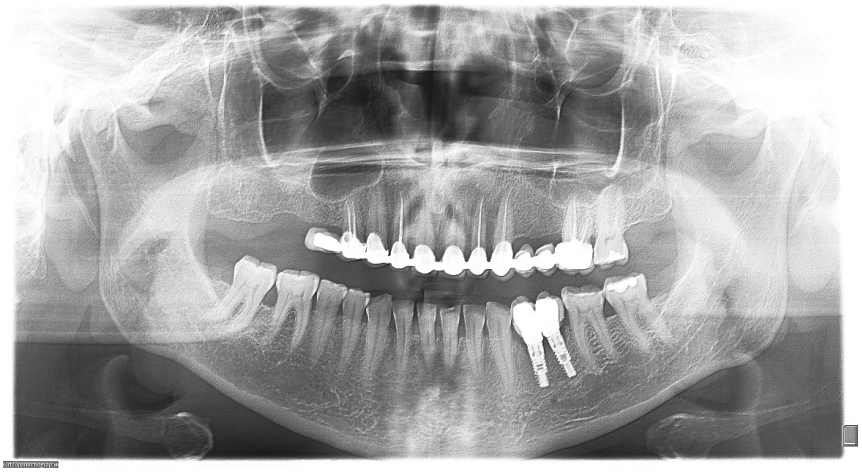

Figure 4. *Radiographic evaluation of two adjacent implants 6 months after prosthetic treatment.*

The influence of systemic conditions in the osseointegration process is poorly documented.[18] Alsaadi et al.[19] noted that Crohn's disease and osteoporosis were associated with increased implant failure; and that gastric and cardiac disease, controlled diabetes type I and II, hypertension, problems with coagulation, hypercholesterolemia, hypo- or hyperthyroidism, claustrophobia and asthma were not related. In osteoporotic patients, with oral bisphosphonates may be a potential risk factor for osteonecrosis of the jaws, rather than osteoporosis as a risk factor for implant success and survival.[16] Also, another study it was suggested, chemotherapy and radiotherapy of oral tissues were significantly related to implant failure.[14] In our case patient was systemically healthy, and follow-up medical evaluations were unable to detect underlying abnormalities.

Several studies reported on the negative effect of smoking on osseointegration.[20,21] The vasoconstrictive action of nicotine; excess levels of carboxyhemoglobin in the blood and impaired polymorphonuclear neutrophil leukocyte function are possible mechanisms leading to impaired wound healing.[14] However, results from the present studies[22-,24] failed to demonstrate significant differences between smokers and non-smokers and tobacco use alone cannot be considered as a risk factor for early implant failures. The impact of smoking may be more important to long-term implant failures than to early implant failures.[22- 24]

A local risk factor is any situation that could pose a risk to successful osseointegration and restoration of a dental implant at the level of the implant site and surrounding teeth.[17] Surgical trauma (overheating) together with inadequate bone volume and quality are generally believed to be the most important local etiological factors for early implant failures.[3] It has been suggested that type 4 and 1 bone types have slightly higher failure rates[5,19] and lack of primary stability or micro motion produced after implant placement preventing osseointegration process.[25] Bone quality in the implant sites in our case was deemed adequate, and good primary stabilization of implants was observed. Regions were prepared with copious irrigation and light drilling pressures along with bone tapping where indicated. Implants were also tightened to place without excessive pressures, which can also lead to

bone loss caused by necrosis of bone cells. Implants which are simultaneously placed with bone graft materials and/or guided tissue regeneration have postsurgical foreign body reaction. This may be the explanation of higher percentage of implants with early progressive bone loss in cases where bone graft and/or membrane are used at the time of implant placement.[13] But in our case no augmentation procedure was utilized.

In implant surgery; the periodontal and endodontic state of neighboring teeth must be taken into consideration. Higher failure rates were reported when implants were inserted next to neighboring teeth than implants in an edentulous ridge.[19] In addition, implants placed next to asymptomatic, endodontically treated teeth[11] or implants inserted next to endodontically treated teeth with periapical lesions have been reported to be associated with greater failure. In our case, teeth adjacent to implants were free from either periapical endodontic lesions, prior endodontic therapy, pulpal symptoms or caries.

Nelson et al.[26] was hypothesized that extra radicular bacteria may persist in apparently healed alveolar bone from previously infected sites, and that these microorganisms may proliferate to trigger early implant failure where bone quality, quantity, and primary stability are optimal. Therefore they conducted a study; 77 microbiological samples were taken from 16 pre-implant extraction sockets, 56 healed post-extraction osteotomies at fixture placement, and five failed fixtures. Tissue fluids and bone samples were analyzed by either anaerobic/aerobic culturing or DNA molecular techniques. They have presented evidence that bone from previously infected and apparently healed sterile sites may harbor bacteria (including Veillonella atypica, Veillonella parvula) as a contamination, which may be reactivated to an infection during clinical implant therapy. However, the teeth were extracted 10 years ago in the present case. During peri-implant biofilm formation the microbial composition alterated from a predominately gram-positive non-motile, aerobic and facultative anaerobic composition towards a flora with a greater proportion of gram-negative, motile, anaerobic bacteria.[27] A metabolic interaction with Veillonella species, which coaggregate with Streptococci.[28] Veillonella species are small, usually non-fermentative, strict anaerobic, gram-negative cocci which are routinely isolated from the oral cavity, the upper respiratory tract, small intestines and vagina.[29] In addition, in this report periodonto-pathogenic bacterial sources of contamination were likely minimal as periodontal health existed at the time of implant placements, although no follow-on bacterial sampling.

CONCLUSION

It can be speculated that some other undiscovered causes such as an unascertained bone pathology or contamination of surgery sites before implant placement may lead early implant failing cases. Bone debridement appears to decrease the number of persistent bacteria in the site of the formerly infected periapical region and the presence of microorganisms resistant to antibiotics (especially penicillin) should not be forgotten. In addition, immediate diagnosis and therapy of early progressive bone loss around dental implants are the key factors to save early failures. Re-evaluation visits (2-4 weeks) after implant placement to detect any signs of early failure and immediate therapies can be achieved if needed.

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Immediate Prosthetic Treatment of an Edentulous Patient With "All-On-4®" Concept

Alper UYAR[1], Simel AYYILDIZ[1], Bülent PİŞKİN[1], Can DURMAZ[2]

ABSTRACT

Background: Protocols of immediate and early loading of dental implants are well documented and described. "All-on-4" technique has become an alternative option for fixed immediate rehabilitation of edentulism especially with severe bone loss.

Objective: In this case report it is aimed to present full mouth immediate restoration of an edentulous patient following the concept of "All-on-4".

Case Description: After radiographs and pictures taken, a CT scan was performed and diagnostic models were prepared. Following the placement of the implants and ending the surgery, impressions were taken and dentures, fabricated before the surgical phase, were checked. These dentures were converted to screw retained prostheses in the lab and placed next day. After three months, hybrid prostheses were fabricated and screwed in place. After one-year follow-up, any problems were encountered.

Practional Implication: With immediate loaded screw retained provisional dentures, patient's esthetic and functional expectations were met in the shortest time period possible.

Keywords: *Immediate loading, edentulism, all-on-4*

ÖZET

Giriş: Dental implantların immediat ve erken yükleme protokolleri ayrıntılı şekilde tanımlanmıştır. "All-on-4" tekniği özellikle ciddi kemik kaybı bulunan tam dişsizlik vakalarında bir immediat sabit tedavi seçeneği haline gelmiştir.

Amaç: Bu olgu raporunda tam dişsiz bir hastanın "All-on-4" konsepti kullanılarak immediat rehabilitasyonunun sunulması amaçlanmıştır.

Olgu Sunumu: Hastanın radyografilerinin ve fotoğraflarının alınmasının ardından Bilgisayarlı Tomografi görüntülemesi yapılmış ve tanı modelleri hazırlanmıştır. İmplantlar yerleştirildikten hemen sonra, cerrahi prosedürden önce hazırlanan tam protezler uyumlanmış ve ölçü işlemleri gerçekleştirilmiştir. Protezler model üzerinde modifiye edilerek immediat vidalı sabit protezler haline getirilmiş ve bir gün sonra ağza takılmıştır. Takip eden üçüncü ayın sonunda metal altyapılı porselen protezler için ölçü işlemleri tekrarlanarak hastanın daimi restorasyonları hazırlanmıştır. Bir yıl boyunca yapılan kontrollerde herhangi bir sorunla karşılaşılmamıştır.

Klinik Uygulamalar: İmmediat yükleme ve vidalı implant destekli geçici protezler sayesinde hastanın estetik ve fonksiyonel beklentileri mümkün olan en kısa sürede karşılanabilmiştir.

Anahtar Kelimeler: *immediate yükleme, dişsizlik, all-on-4*

[1] *Department of Prosthodontics, Dental Health Sciences Center, Gulhane Military Medical Academy, Ankara, Turkey*
[2] *Oral Surgeon, Private Clinic, Ankara, Turkey*

INTRODUCTION

A certain part of the population suffers through non- restorable and unsustainable terminal dentition such as; failing restorations, multiple tooth losses and severe periodontal diseases. The remaining teeth of such patients are often in poor condition and not suitable for support. These patients usually become edentulous after a long and painful period and start wearing removable dentures. As an alternative to the complete dentures, osseointegrated implant supported fixed restorations give the patients their long lost life-quality back. Adequate number of implants to support fixed dentures for the rehabilitation of edentulous jaws is stated by the Bränemark protocol as 6 to 8.[1] Beside the financial burden, caused by the high implant numbers, rehabilitation of edentulous jaws that have poor bone quality or severe resorption may be challenging for surgeons and prosthodontists both.[2] Although there are many reconstructive techniques to increase the bone volume, particularly for reduced bone height in posterior region, and to establish suitable sites for the placement of required number of implants, patients generally avoid these techniques due to the long healing periods, multiple surgical phases and high costs.[3]

These limitations led to the researches for a solution with fewer implants. The All-on-4® concept, a surgical and prosthetic protocol, has been well documented and published with prosthetic survival rates of 93- 99%.[3,4]

The method was based on using 4 implants of which distal two were placed tilted with an angle of 30^0 to 45^0 to prevent possible interferences with sinus or mental foramen during surgery, to minimize the need for reconstructive surgery and provide a higher anchorage and primary stability. Moreover, these angulations increase the inter-implant distances for better prosthetic support by shorter cantilevers and improved load distribution.[4]

In the last years, the immediate placement and loading procedures of the implants for the rehabilitation of edentulous patients have become a common treatment protocol among the clinicians. The reason of the popularity is the need to regain aesthetics, function as soon as possible and the high success rates of the method, reported by previous studies.[5-9]

This case report aims to present the rehabilitation of an edentulous patient with concerns on appearance and hardships of using removable dentures.

CASE REPORT

A 55-year-old male patient with an unremarkable medical history referred to Gülhane Military Medical Academy, Department of Prosthodontics with the request of being treated with fixed prosthesis. Following the intraoral examination and radiographic evaluation, a CT scan was performed. It was seen that all teeth but a single lower left canine were lost and bone defects in maxilla were noted (Fig.1). Alginate impressions for diagnostic study casts were made and photographs were taken. Smile line and visibility of the periodontium were evaluated. Finally, implant supported hybrid prostheses were chosen for the rehabilitation of the patient and regarding treatment costs and patient's immediate treatment request, "All-on-4®" concept was used.[10]

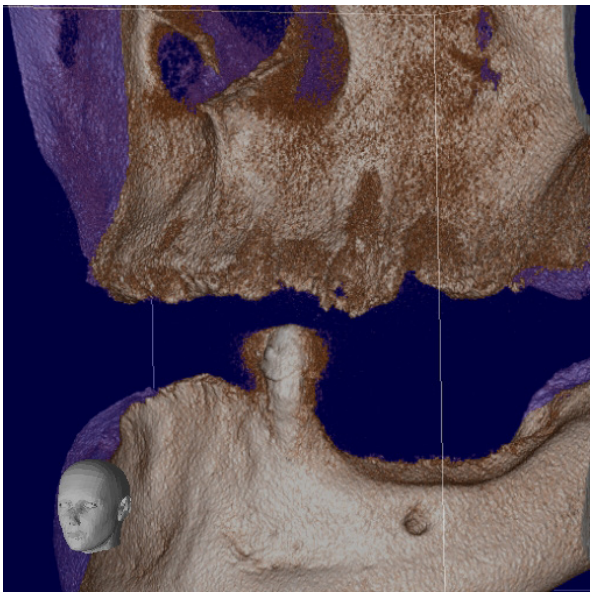

Figure 1. *Bone defects and remaining tooth in CT scan image.*

Diagnostic models and a wax-up were made, and transitional complete dentures and surgical stents were fabricated.

After flap elevation, the remaining tooth was extracted and alveolar ridges were reduced vertically, where needed, to establish a sufficient interarch distance and a platform like surface. 8 implants (Oxy OsseoNova Internal Hexagon, Colico, Italy) were placed according to the manufacturer's guidelines. Posterior implants (4,75x15mm) were inserted distally tilted to avoid maxillar sinus and foramen mentale between first and second premolar regions while anterior implants (3,75x11 for maxilla, 4,75x13mm for mandibula) were placed in to the lateral incisor regions. All implants were placed with primary stability using a manual torque wrench with 50 Ncm. 35° and 17° angled base abutments with different collar heights were chosen for each implant and screwed to the tilted and anterior implants respectively with a torque limit of 25 Ncm. The tissues were repositioned and sutured after bone grafts were used for the augmentation of bone defects.

Between implant placements of maxilla and mandibula, upper interim denture was modified according to the implant locations and abutment positions. Occlusal relation was checked and the denture was relined. Following mandibular implantations and abutment placements same procedure was repeated for lower denture.

Multi-unit impression copings for open-tray technique were screwed onto the abutments and splinted with dental floss and auto-polymerizing resin (Pattern Resin, GC America, Illonis, United States). Impressions were made using a polyvinyl siloxane material (Zhermack Elite HD, Zhermack SpAVia Bovazecchino, Italy). Healing caps were screwed in place following the impressions and surgical stage was completed.

After the casts were made, temporary cylinders were screwed on the analogs and using autopolymerizing acrylic resin (Meliodent, Heraus-Kulzer, Germany) the transfers were splinted in to the denture. Before the insertion of the dentures, flanges and distal extensions were removed. Screws of the immediate prostheses were torqued to 15 Ncm and the occlusion was adjusted (Fig.2). Controls were made after one week and every month.

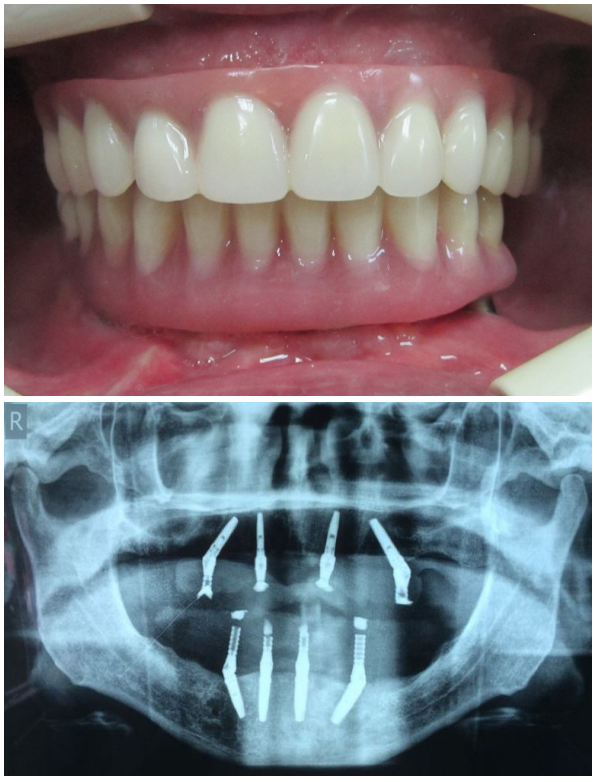

Figure 2. *Immediate screw-retained acrylic prostheses after 1 month. Acrylic fracture at the left molar region of lower denture is seen.*

Three months after the surgery, open tray impressions were made for the definitive restorations after the removal of the interim denture. Co-Cr metal frameworks were casted in laboratory. The frameworks were checked for passive fit then screwed on the abutments and maxillomandibular relation was recorded. Following porcelain veneering, occlusion, centric relation, aesthetics and phonetics were evaluated and necessary modifications were made at the try-in session. Completed restorations were inserted and screwed in place with a torque of 35Ncm (Fig. 3). The screw holes were filled with composite resin material that matches the porcelain shade (Filtek Z 250 Universal Restorative, 3M ESPE, St Paul, Minneapolis, United States).

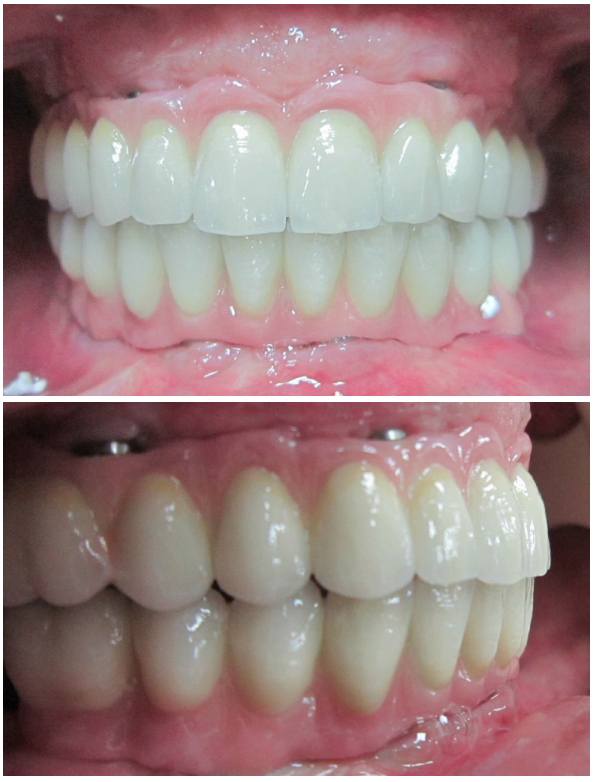

Figure 3. *Definitive prostheses.*

After the placement of the dentures, hygienic measures were explained to the patient and control appointments were arranged as 1 day, 1 week, 3 months and 1 year. The patient was satisfied with the esthetic and functional outcomes of his prostheses. Implants and surrounding bone were examined with an OPG after three months and one-year (Fig.4). No problem of osseointegration, soft tissue profile, function or aesthetics was observed in one-year follow-up period.

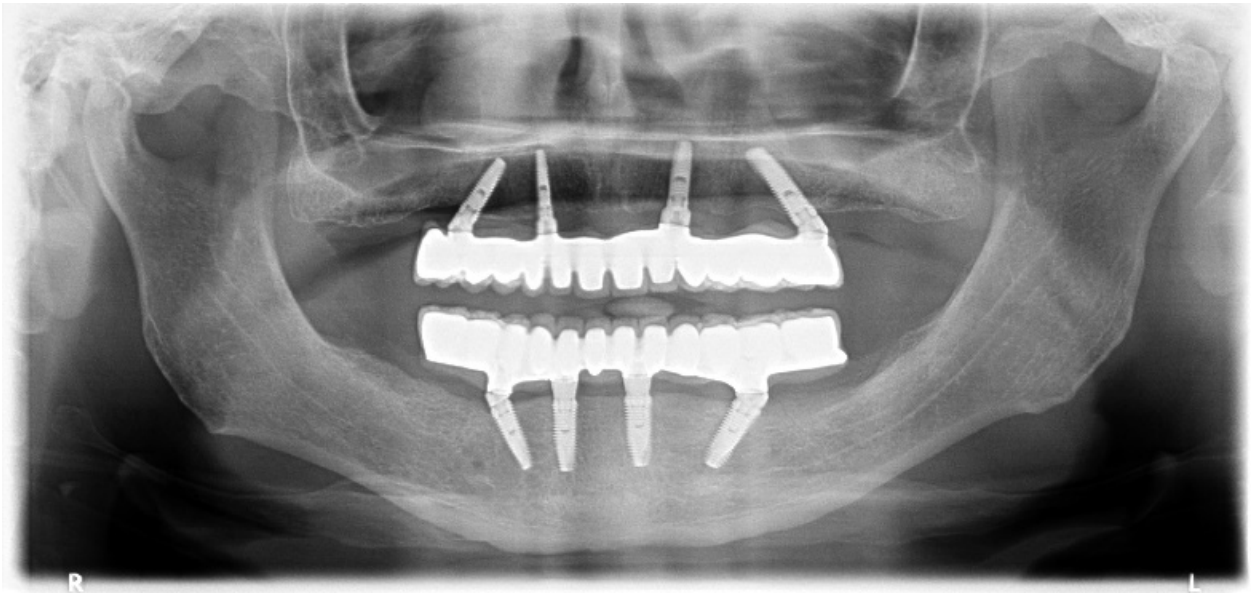

Figure 4. *OPG after 1-year.*

CONCLUSIONS

The All-on-4 concept is a successful treatment option with excellent clinical results and it is achieved without major reconstructive surgery. The reduced number of implants drags down the cost compared to traditional implant supported fixed restorations. However, careful considerations and a detailed pretreatment planning have to be made on aesthetic and functional outcomes. Therefore; smile line, amount of the vertical bone loss, and crown height space should be evaluated before the implant supported hybrid dentures were chosen for the rehabilitation of the edentulous patient. Advantages and disadvantages of fixed and removable options should be explained and discussed with the patient. An overdenture can be maintained with simpler hygiene practices, which may be beneficial for the elderly patients. Also a removable prosthesis would be more useful in case of a serious need of lip support, as the flange on a removable solution may assist in supporting the facial contours.

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Orthodontic and Surgical Approach: Accelerated Osteogenic Orthodontics

Orhan AKSOY[1], Fatma YILDIRIM[2], M. İrfan KARADEDE[3]

ABSTRACT

The development of surgically-assisted orthodontic treatment offers solutions to many limitations in orthodontic treatment. This new method has several advantages including reduced treatment time, increased limits of tooth movements, increased amount of alveolar bone, reduced need of extraction, rapid eruption of impacted teeth, and further enhanced post-orthodontic stability. The aim of this article is to present a review of the literature, including historical background, contemporary clinical techniques, advantages, and indications and contraindications of accelerated osteogenic orthodontics.

Keywords: *Accelerated orthodontics, surgically-assisted orthodontic tooth movement*

ÖZET

Cerrahi destekli ortodontik tedavilerin gelişimi, ortodontik tedavilerdeki bazı sınırlamalara çözüm sunmaktadır. Bu yeni yöntem, azalmış tedavi süreleri, diş hareket limitlerinde ve alveolar kemik miktarında artma, çekim ihtiyacını azaltma, gömülü dişlerin hızlı bir şekilde sürdürülmesi ve son olarak tedavi sonrası stabilitenin geliştirilmesini içeren birçok avantaj sunmaktadır. bu makalenin amacı, hızlandırılmış ortodontik tedavinin tarihsel arka planı modern klinik teknikleri, avantaj dezavantajları, endikasyon ve kontrendikasyonlarından oluşan literatür derlemesini sunmaktır.

Anahtar Kelimeler: *Hızlandırılmış ortodonti, cerrahi destekli ortodontik diş hareketi*

[1] *Istanbul Aydın University, Faculty of Dentistry, Department of Orthodontics*
[2] *Istanbul Aydın University, Faculty of Dentistry, Department of Orthodontics*
[3] *Izmir Katip Celebi University, , Faculty of Dentistry, Department of Orthodontics*

INTRODUCTION

Aesthetics and duration of treatment are two important issues that patients are concerned with. Aesthetic problems have been overcome with the use of porcelain or lingual braces. In addition, new technologies on wires and braces have focused on reducing the treatment time. Still, some patients wish their duration of treatment to be even shorter. Accelerated orthodontic treatment (or accelerated osteogenic orthodontics [AOO]) is a new method that reduces the duration of treatment. Besides, the AOO technique provides more efficient orthodontic tooth movements and stable results.

Historical background

The studies conducted over the last 50 years have revealed that the tooth movements are accelerated after corticotomy procedures. First, in 1892, L. C. Bryan mentioned about the use of corticotomy for the correction of malocclusions. [1] In 1959, Heinrich Köle corrected the malocclusions with corticotomy by weakening the medullary bone along the apex and the root of tooth. [2] In subsequent periods, many authors corrected the malocclusions with decortication of alveolar bone and reported that the rapid tooth movements were obtained by en bloc displacement of bone.[1]

In 2001, two brothers, William M. Wilcko who is orthodontist and Thomas Wilcko who is periodontist, introduced the Wilckodontics® System. In this method, the cortical areas creating resistance to tooth movements are removed by using corticotomy and the tooth movements are accelerated.[3] They mentioned some bone activations during the tooth movements and they achieved it by using a resorbable bone graft substitute. In this way, performing the orthodontic treatment with bone augmentation helps in the formation of a new bone in that region; otherwise, no new bone formation is likely to occur. On this topic, Wilcko brothers hypothesized that rapid tooth movements result from the remineralization-demineralization mechanism of the bone, not from the en bloc displacement of the bone. Moreover, they substantiated their hypothesis through a computed tomography (CT) analysis both before and after the treatment. This technique is endorsed by the American Association of Periodontology and called as "Accelerated Osteogenic Orthodontics".[1,] (Fig. 1)

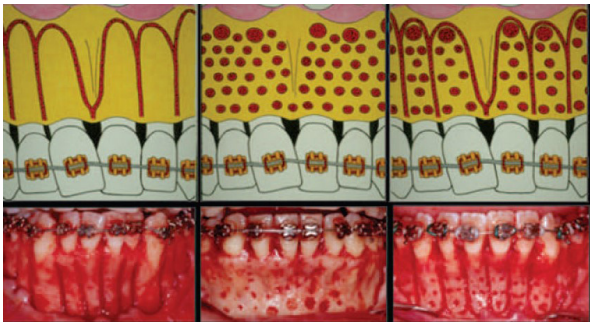

Figure 1. *Corticotomy and bone perforations* [1]

Indications and Contraindications

Indications of AOO are as follows:

1) To increase the limits of tooth movements and reduce the need of extraction
2) To shorten the duration of orthodontic treatment.
3) To increase the amount of alveolar bone and obtain more robust periodontium.
4) To replace the lost bone volume in cases of dehiscence by reshaping the alveolar bone.
5) To accelerate the eruption of the deeply impacted teeth[1, 2, 3] (Fig. 2).

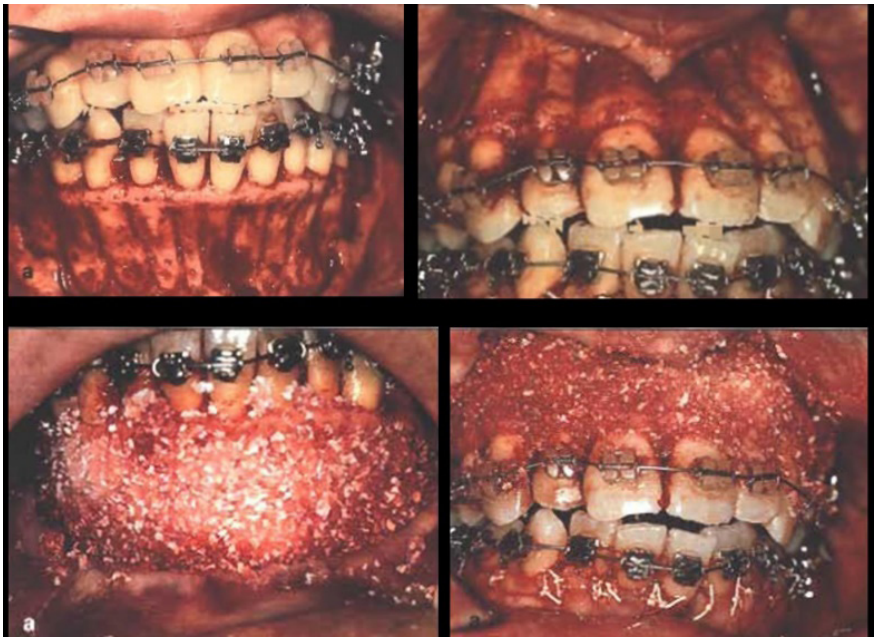

Figure 2. *Rapid orthodontic decrowding with alveolar augmentation* [2]

Wilcko brothers claimed that this technique could be applied to any patient in whom fixed orthodontic treatment can be performed. However, there are some contraindications:

1) Active periodontitis
2) Uncontrolled osteoporosis or other kinds of bone diseases
3) Any disease that requires the use of long-term anti-inflammatory or immunosuppressive drugs, or steroids
4) Patients with any disease that leads to delayed healing process
5) Use of nonsteroidal anti-inflammatory drugs (because the active agent is an inhibitor of prostaglandin and thus osteoclastic activity is reduced). [1, 2, 3]

Clinical Procedures of AOO

This treatment is a multidisciplinary procedure, requiring successful operation of the surgeon and a well-planned treatment by an orthodontist. As this method requires a major surgical procedure, the patient is required to maximize the oral hygiene.[5]

The procedure begins with orthodontic treatment. The bands and braces are placed and if the second molars are present, they are banded in order to enhance the anchorage. The reason for this is to avoid losing control of tooth movements due to the weakening of the cortical bone in the surgical site. A light Ni-Ti wire is ligated to the braces within several weeks prior to the surgery.[2]

Preoperatively, the IV sedation is given to the patient and the surgical procedure is initiated under local anesthesia. The crevicular incision is made buccally and lingually extending a minimum of two or three teeth beyond the area to be treated. A full-thickness flap is reflected on both buccal and lingual aspects from the both sides of the premolars. The surgeon must avoid vertical incisions as much as possible for the purpose of maintaining the nutrition of tissues. A full-thickness flap is raised up to the root levels except for the papillary region of the maxillary central incisors because the nasopalatine foramen plays a very important role for the tissue nutrition in that region. Care

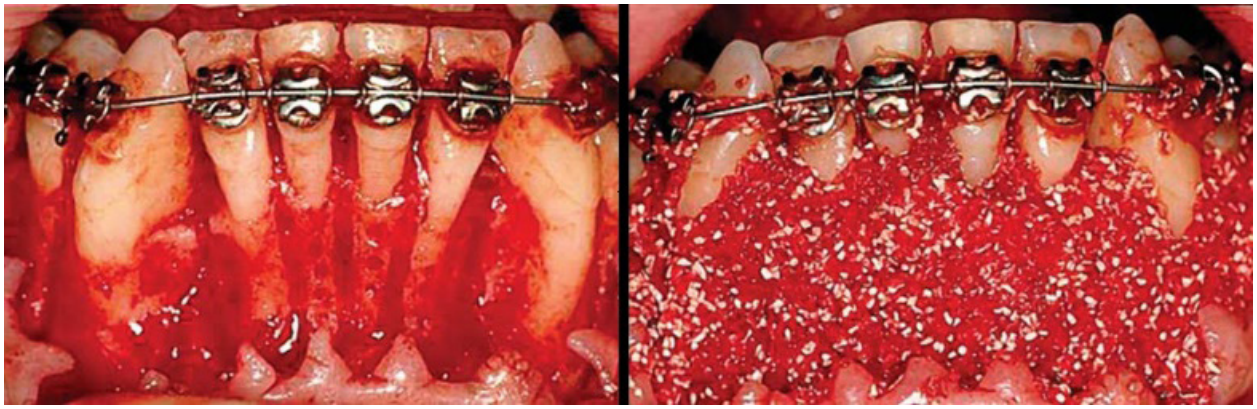

Figure 3. *Bone decortication and placement of bone grafts*[9]

should be taken not to damage any of the anatomical structures in both arches.[2]

After the flap is lifted, a high-revolution speed physiodispenser with a long-neck, sharp, steel round bur is used for the weakening of the bone after forming small circular-shaped perforations along with corticotomy cuts between 2-3 mm below the alveolar crest and 2-3 mm below the root apex. The bone is weakened with the cortical perforations to increase blood supply. If the corticotomy is made only from the labial region, an ideal bone demineralization would not occur, mainly due to asymmetrical bone weakening. If the bleeding is not sufficient for the tissue nutrition, additional corticotomy can be performed. Following the corticotomy cuts, there should be no bone luxation in that region.[2]

Allograft material (demineralized frozen-dried bone allograft) and calf bone graft material (Bio-Oss) are dry mixed to obtain resorbable bone graft material in order to ensure the bone augmentation, which are then placed over the decorticated areas mixed with clindamycin phosphate solution. The grafts with 2 or 3 mm thickness are spread under the flap and the flap is sutured with 4/0 Gore-Tex suture without sliding. Care should be taken to ensure that the papillae are placed in their original locations. The reason for using resorbable graft is both the activation of new bone formation and the more regular healing of the damaged regions.[2] (Fig. 3)

As mentioned previously, the canine retraction and the eruption of the impacted teeth are also included in the indications of these operations. The surgical and orthodontic procedures in the canine retraction process are almost the same. The braces are bonded 2 weeks before the surgery and a very light NiTi wire is placed.[2] IV sedation is given to the patient before surgery and the surgery is performed under local anesthesia. The labial and lingual full-thickness flap is removed and the first premolar teeth are extracted. If possible, the cortical bone surrounding the extraction side is weakened to the apex of the canine roots. However, this weakening should be limited to the labial, lingual and distal surfaces of canines. After corticotomy, 9 ccs of bone graft including two-thirds of cortical graft and one-third of calf bone graft is placed and sutured. Two weeks later, the sutures are removed. Naturally, the distal movement of canine is naturally desired. Therefore, the thinnest area in mesio-distal direction must be the distal part of the interseptal bone. If the mesial part of the interseptal bone of the second premolar teeth is too thin, a second premolar mesialization, which is an undesirable situation, occurs together with canine distalization. Care must

be taken during the cortical bone weakening surgery to avoid damaging the anatomical structures such as maxillary sinus in the upper jaw and the inferior alveolar neurovascular bundle in the lower jaw. This operation increases the rate of canine distalization movement compared to the canine retraction mechanics without corticotomy. [6]

Following the operation, the patient is usually prescribed 250 mg antibiotics (penicillin derivatives) four times a day. 550 mg naproxen sodium derivatives such as analgesic agents are given and the patient should be advised to maximize oral hygiene. 4 of 5 days after the surgery, the patient should be advised to visit the clinic for a follow-up check. The aim of this visit is to check whether there is any sliding or separation of the flap. The sutures are removed two weeks after the surgery and the orthodontic treatment can be resumed several days later.[6]

Gürgan et al. [7] reported that the canine retraction procedures normally last 6 or 8 weeks but if the distraction osteogenesis procedures are performed, then it lasts 8 or 14 days. In this study, the retraction force was applied to the canine 3 days after the distraction surgery. The rate of distraction was 0.8 mm per day, divided into two 0.4 mm equal increments. The second premolar and the first molar teeth were used as an anchorage and there was no anchorage loss. Mild inflammation was observed after the operations, but this did not disturb the patients in the postoperative period. In clinical and radiographic examinations, no root resorption, devitalization, or periodontal problems were observed. The study concluded that the fixed orthodontic treatment should be immediately initiated as soon as the desired amount of retraction is achieved.[7]

Sebaoun et al.[8] conducted a study on rats and reported that the modeling of the trabecular bone and lamina dura was 3 times faster following selective alveolar decortication.

Tissue healing after alveolar decortication consists of three stages. In the first stage, the local tissues begin to renew themselves rapidly, leading to the formation of osteoprogenitor cells and osteoinductive agents. In the second stage, the slow tissue healing is accelerated, which is called "osteopenia" and means that the density of bone is decreased with no change in the amount of bone. Finally, proper anatomical areas occur and these areas provide rapid tooth movements through effective biomechanical forces. Rapid tooth movements persist until alveolar decalcification is completed as a result of medullar bone osteopenia. In this way, the rate of orthodontic treatment is increased 2-3 times compared to treatment without the application of AOO.[1]

So, is the rate of the treatment the only advantage of AOO?

Certainly, no. This procedure increases not only the rate of the treatment but also the amount of tooth movements. Proffit [8] reported that the tooth movements are limited in adult orthodontic patients. According to Proffit, 7 mm retrusion, 2 mm protraction, 4 mm extrusion, and 2 mm intrusion occur in the upper central incisors with standard orthodontic therapy, whereas 8 mm retrusion, 5 mm protraction, 10 mm extrusion, and 5 mm intrusion occur after alveolar decortication procedures. During these movements, the amount of alveolar bone increases with no expansion in midpalatal suture and the orthodontic treatment can be performed with no need for tooth extraction in moderate crowding cases. [1]

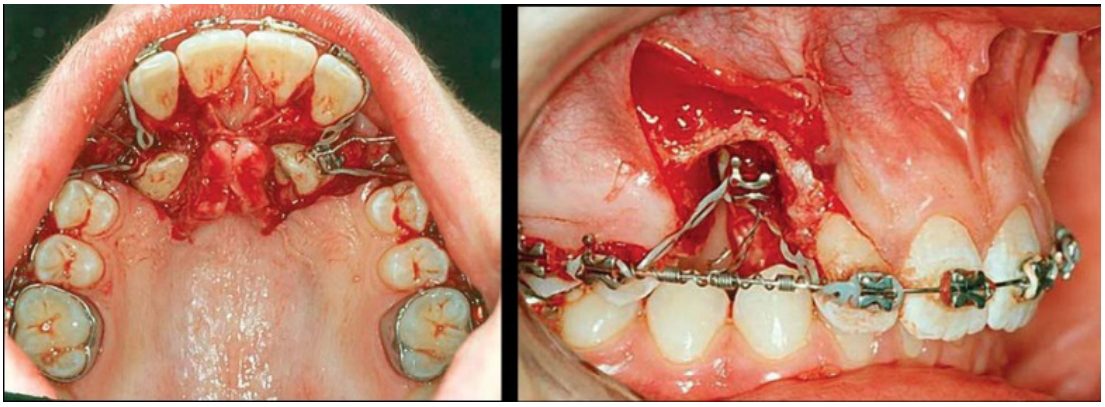

Figure 4. *Rapid eruption of impacted canines.* [8]

In the lower central incisors, 3 mm retrusion, 5 mm protraction, 2 mm extrusion, and 4 mm intrusion occur following the standard procedure, whereas 4 mm retrusion, 9 mm protraction, 6 mm extrusion and 7 mm intrusion occur after alveolar decortication. [1]

One of the most important situations prolonging the period of orthodontic treatment is impacted teeth. Canines, premolars, incisors, and particularly the third molars often remain buried and the treatment of impacted teeth should be carried out through cooperation between the surgery and orthodontics clinics. The duration of these treatments can vary in different cases. The success of treatment is higher in younger patients; however, the risk of ankylosis increases with age and this adversely affects the treatment success. Prior to the orthodontic eruption of impacted teeth, stainless steel wires must be passed into the arch in order avoid tipping of the neighboring teeth. The localization of impacted teeth is one of the factors that affect the success and duration of the procedure. If the impacted teeth go beyond the alveolar bone and remain under the gums, the window form incision is made without lifting the flap, the bracket is placed and the tooth is erupted. [9] (Fig. 4)

Nevertheless, the situation may be different if it remains under the alveolar bone. In this case, it is necessary to completely open the clinical crown, the bone around the impacted tooth should be weakened with alveolar decortication, and the eruption way should be guided by the alveolar osteotomy cuts. This requires a major surgery compared to the first situation. The impacted teeth may be positioned labially or buccally. The full-thickness mucoperiosteal flap is elevated from the labial sulcus for labially positioned teeth. In the cases of canine eruption, the borders of the flap must include the first premolar and lateral incisor in order to keep the working area broad and thus to prevent the tearing of the flap and to provide better nutrition. There is no need to remove the lingual flap in addition to the labial flap. However, care should be taken to retain 1.5 mm bone both at the mesial and distal sides of adjacent teeth. [10]

The eruption procedure of lingually impacted teeth is slightly different and performing decortication in such situations will help a lot in this area. Both labial and lingual full-thickness mucoperiosteal flaps are elevated and the flap is released with vertical incisions in order to reach the deeply impacted teeth more easily. After decortication, at least 1.5 mm bone should be remained at the mesial and distal sides of adjacent teeth. To the possible extent, the bracket should be placed at an ideal location. If no opportunity is available

for this placement, the distolabial area can be preferred. After all these processes, sutures are tied and are later removed approximately a week later and the force is applied for tooth eruption. [10]

Disadvantages of AOO

It is a mildly invasive surgical procedure and like all surgeries, it has its risks like pain and possibility of infection. Extra-surgical cost is one of the disadvantages of this procedure. The crestal bone loss and gingival recessions may occur. Proper case selection is necessary to attain a good result. For example, this technique is not recommended in Class-III malocclusions.[1] And also patients who take NSAIDS on regular basis or have other chronic health problems cannot be treated with this technique.[11]

CONCLUSION

Throughout human history, people have developed many ideas and the new technologies produced by humans have systematically made our lives more comfortable and prosperous. Orthodontic treatment combined with surgery may seem challenging and the patients may feel discomfort after the operations; however, this period may last only 3-4 days with good oral hygiene and medical support. More efficient orthodontic treatments which may last as short as 6-8 months, compared to traditional orthodontic treatments which last 20-24 months, provide more stable results as well as increased bone support. Moreover, these treatments are more popular since they provide greater aesthetic and healthy periodontal status. Considering that the procedure is a good example of team work, any mistake in surgery or orthodontics affects the success of the treatment.

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Abstract max 250 words and 3-10 key words (double spaced)
Main text with appropriate section headings (double spaced)
References (double spaced), on a new page
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Figures and/or illustrations should be JPG/TIFF format and separate files