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## Četverogodišnja procjena aproksimalno infiltriranih lezija kod adolescenata

### Four year Evaluation of Proximal Resin Infiltration in Adolescents

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#### Sažetak

**Svrha:** Infiltracija aproksimalnih lezija kompozitom novi je pristup u sprječavanju progresije karijesa. Svrha ovog istraživanja bila je procijeniti kod adolescenata četverogodišnji učinak toga postupka. **Materijali i metode:** Desetero adolescenata pristali su na infiltraciju 21 aproksimalne lezije ICON®-om (DMG, Njemačka) u području trajnih inciziva i premolara. Postupak je obavljen u skladu s uputama proizvođača. Klinička procjena kvalitete infiltrata učinjena je nakon tjedan dana, te nakon jedne, dvije, tri i četiri godine poslije inicijalnog zahvata. Terapeutski učinak procjenjivao se na temelju rendgenskih snimki. **Rezultati:** Desetero pacijenata praćeno je četiri godine. Velika većina infiltriranih lezija locirana je na trajnim incizivima. Infiltrirani zubi nisu imali dentalni plak, niti su oko njih krvarile desni. Na godišnjim pregledima indeks plaka bio je konstantan. Gingivalni status također je ostao isti i nije bilo promjena u obliku zuba. Promjena boje uočena je na četiri zuba (19 %) tijekom pregleda nakon godine dana, no na sljedećim kontrolama nije bilo promjena. Četiri godine nakon prve snimke radiološka slika nije pokazala napredovanje ni jedne od 21 lezije. Oralna higijena pacijenata bila je vrlo dobra. **Zaključak:** Aproksimalna infiltracija kod adolescenata učinkovita je profilaktička metoda.

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#### Ključne riječi

test napredovanja zubnog karijesa; rubno prijanjanje materijala za punjenje; dentalni cementi; kompozitne smole; dentalna preventiva

#### Uvod

Aproksimalne kariozne lezije velik su problem u adolescenciji (1). Istaknimo da je pritom vrlo važna rana dijagnoza, ali također je bitno zaštititi površinu lezije od acidogenih bakterija i ugljikohidrata. Dobri rezultati u tretmanu aproksimalnih lezija postignuti su upotrebom stakloionomernih cementa, kompozitnih smola, adheziva i poliuretanskih zavoja, što je navelo stručnjake na istraživanje novih materijala (2 – 6). Osim navedenih materijala koji pokrivaju aproksimalne lezije, postoje i niskoviskozni smolasti materijali koji infiltriraju kariozne lezije kroz njihovu poroznost i svjetlosno se stvrdnjavaju. Metoda se zove infiltracija karijesa, a tehnika je nazvana infiltracijskom (7). Postoji ograničeni broj istraživanja koja se bave tim tehnikama (8 – 13). Rezultati ovih istraživanja obvezujuć su. Posebno se ističe velika učinkovitost u smanjenju napredovanja karijesa, jednokratni posjeti te mogućnost primjene metode. Upravo zbog navedenih razloga potrebno je više dokaza i dugotrajno praćenje infiltriranih lezija. Svrha ovog istraživanja bila je procijeniti učinkovitost infiltrata kod adolescenata četiri godine nakon inicijalne terapije.

#### Introduction

Early proximal caries lesions pose a serious problem in adolescence (1). While early diagnosis of these lesions is vital, it is also important to preserve the lesion surface from acidogenic bacteria and carbohydrates. Recently, proximal sealing with glass-ionomer cement, composite resin, bonding material and polyurethane patch offered good results in proximal lesions directing researchers in new material search (2-6). Apart from the abovementioned idea of proximal caries sealing, there is the term 'caries infiltration' where the porosities of the lesion body are further penetrated by low viscosity light curing resins, so called 'infiltrates' (7). There is a limited number of studies dealing with the infiltration technique (8-13). The results of these studies are promising, highlighting its high efficiency in reducing caries progression, requirement of only one visit and an applicable method. However, more evidence is needed to see the long-term results of infiltrates. Therefore the aim of the present study was to evaluate the 4-year efficacy of infiltrates in adolescence.

## Materijali i metode

U istraživanju je sudjelovalo desetero adolescenata (6 mladića i 4 djevojke, u dobi od 14 do 17). Kriterij za uključivanje bila je radiološki procijenjena aproksimalna lezija u caklini ili u vanjskoj trećini dentina na trajnom zubu, a razlozi za nesudjelovanje u studiji bili su sistemske bolesti, alergije i klinički vidljive kavitacije na testiranim aproksimalnim površinama.

Svi pacijenti koji su sudjelovali u istraživanju i njihovi roditelji potanko su obaviješteni o proceduri te su potpisali informirani pristanak. Zagrizne (tzv. *bitewing*) snimke snimljene su digitalnim rendgenom (Vista Scan, Dürr Dental, SAD). Klasifikacija 21 aproksimalne lezije obavljena je prema sljedećim kriterijima Parisa i suradnika (12):

- radiolucencija u vanjskoj polovini cakline (E 1),
- radiolucencija u unutarnjoj polovini cakline (E 2)
- radiolucencija koja se prostire u vanjskoj trećini dentina (D 1).

Radiolucencije s prostiranjem u srednju (D 2) i u unutarnju trećinu dentina (D 3) nisu bile uključene u istraživanje. Medicinska anamneza i stomatološki status uzeti su tijekom prvog pregleda.

Prije tretmana zabilježen je status oralnoga zdravlja, nakupljanje plaka, karijes i gingivalni status testiranih zuba. Klinički status ocjenjivao se kao zdrav (0) i kao inicijalna kariozna lezija (1), a kariozni defekti (2) bili su isključeni iz istraživanja. Nakupljanje plaka ocijenjeno je prema nedostatku plaka (1), srednjem nakupljanju (2), umjerenom nakupljanju (3) te prekomjernom plaku (4). Gingivalni status ocijenjen je kao zdrav (1), kao krvarenje nakon sondiranja WHO sondom (2), kao otečen (3) i kao jaka upala s krvarenjem (4). Svi pacijenti dolazili su redovito na kontrole te su tada zabilježene njihove navike o pranju zuba i prehrani te nedavna primjena fluorida.

Dvoje iskusnih dječjih stomatologa nanijeli su pacijentima kompozitni infiltrat prema uputama proizvođača (Icon<sup>®</sup> Proximal Mini Kit, DMG, Hamburg, Njemačka). Nakon separacije kolčićem aproksimalna površina zahvaćenog zuba jetkana je 120 sekundi 15-postotnom klorovodičnom kiselinom, a pritom se koristio poseban aproksimalni aplikator propustan samo na jednoj strani (Icon<sup>®</sup> Proximal Mini Kit, DMG, Hamburg, Njemačka). Aproksimalne površine isprane su vodom i sušene 30 sekundi prema uputama proizvođača. Površina je dehidrirana 30 sekundi isušivanjem 95-postotnim etanolom i zrakom. Nakon toga upotrijebljena je smola niskog viskoziteta, infiltrat (Icon<sup>®</sup> Proximal Mini Kit, DMG, Hamburg, Njemačka) u trajanju od 180 sekundi, a pritom se koristio jednostrano propusni aproksimalni aplikator. Nakon što je interdentalnim koncem uklonjen višak materijala, infiltrat je 40 sekundi osvijetljen (Mini L.E.D<sup>®</sup>, Sirona, Bensheim, Njemačka) sa svih strana prema uputama proizvođača. Infiltrat je nakon toga sljedećih 60 sekundi apliciran te osvijetljen. Nakon stvrdnjavanja, aproksimalne površine završene su poliranjem diskovima i trakicama za poliranje (Soft-Lex, 3M ESPE, MN, SAD).

Kliničku procjenu infiltrata obavili su isti kliničari kao i na inicijalnom pregledu. Oni su pacijente pregledali nakon

## Materials and methods

Ten adolescents (6 F, 4 M, age range 14-17 years) participated in the study. Inclusion criteria: to have a proximal lesion in the enamel or in the outer third of the dentine on a permanent tooth assessed radiographically. Exclusion criteria were: systemic diseases, allergies and presence of visible or detectable cavitation on the tested proximal surfaces.

All the patients and their parents who participated in the present study received detailed information about the procedure and were required to give an informed consent. The bitewing radiographs were taken with digital x-ray (Vista Scan, Dürr Dental, USA). The classification of 21 proximal lesions was made according to the following criteria: radiolucency in the outer half of the enamel (E1), radiolucency in the inner half of the enamel (E2), and radiolucency with obvious spread in the outer third of dentin (D1) according to Paris et al. (12). Radiolucency with obvious spread in the middle third of dentin (D2) or in the inner third of dentin (D3) was not allowed in the study. The medical history and the dental status were assessed during the baseline evaluation.

Regarding evaluation of oral health status, plaque accumulation, caries and gingival status of the tested teeth were recorded prior to treatment. The clinical status was scored as healthy (0), initial carious lesion (1), while carious defects (2) were not allowed at baseline. Plaque accumulation was scored as no visible plaque (1), mild (2), moderate (3), excessive plaque (4). The gingival status was scored as healthy (1), bleeding after probing with a WHO probe (2), swelling (3), and strongly inflamed with profuse bleeding (4). All the patients were recall patients where brushing habits, dietary controls and recent fluoride applications were recorded.

Two trained pediatric dentists applied the resin infiltration according to the manufactures' instructions following the flow chart on the box (Icon<sup>®</sup> Proximal Mini Kit, DMG, Hamburg, Germany). After separation with the included wedge, the proximal surface of the test tooth was etched with 15% hydrochloric acid for 120 s using the special proximal applicator, which is permeable only on one side (Icon<sup>®</sup> Proximal Mini Kit, DMG, Hamburg, Germany). The proximal surface was rinsed with water and dried for 30 s according to the manufacturer's instructions. The surface was dehydrated by evaporation of superficially applied 95% ethanol and continuous air-drying for 30 seconds. The very low viscosity resin, the infiltrate, (Icon<sup>®</sup> Proximal Mini Kit, DMG, Hamburg, Germany) was applied to the test lesion for 180 s using another enclosed proximal applicator which is also permeable only on one side. After removal of excess material using dental floss, the infiltrate was light-cured (Mini L.E.D<sup>®</sup>, Sirona, Bensheim, Germany) from all sides for 40 s according to the manufacturer's instructions. The infiltrate was reapplied for 60 s and light-cured. Finally, the contour of the proximal surface was finished and polished with finishing discs and polishing strips (Soft-Lex, 3M ESPE, MN, USA).

The clinical evaluation check of the resin infiltration was assessed by the same examiners at baseline. Patients were clinically re-examined after one week, one, two, three and four years within invitation from the recall system. The same dentists

tjedan dana te zatim ponovno poslije jedne, dvije, tri i četiri godine. Interexaminer kalibracija iznosila je 0,90 (kappa). Klinički status, prikupljanje plaka i gingivitis zabilježeni su prema istim kriterijima kao i na inicijalnom pregledu kako bi procijenili kvalitetu infiltrata.

Svi podatci statistički su analizirani programom SPSS (SPSS16.0 for Windows, SPSS Inc. Chicago, IL, SAD). Opisana statistika i frekvencije korištene su bez obzira na vrstu podataka. Friedmanovim testom uspoređeni su podatci dobiveni na inicijalnom pregledu s onima naknadnima. U svim testovima p vrijednosti ispod zadanih 0,05 smatrale su se statistički značajnima.

## Rezultati

Klinički je bilo praćeno desetero pacijenata. Većina infiltriranih lezija locirana je na trajnim incizivima (tablica 1.). Od 21 lezije, tri su kategorizirane kao E 1, 10 kao E 2 i osam kao D 1. Srednja DMF-S vrijednost za uzorak bila je  $7,3 \pm 2,9$ , što odgovara DMF-T-u od  $4,1.8 \pm 2,2$ . Adolescenti su dobili upute o pravilnoj oralnoj higijeni i prehranbenim navikama. Samo pacijenti koji su dolazili na godišnje preglede bili su uključeni u istraživanje. Svima je bilo preporučeno da se koriste dentalnim koncem. Zubi koji su bili infiltrirani uglavnom nisu imali naslage plaka ni upaljane desni (tablica 2.). Na svakom godišnjem pregledu količina plaka bila je kon-

performed the subsequent recalls. The interexaminer calibration was 0.90 (kappa score). The clinical status, plaque accumulation and gingivitis were recorded according to the same criteria used at baseline. In order to assess the quality of the resin infiltration, the discoloration and marginal adaptation tests were recorded according to the following criteria which have been subdivided from USPHS criteria. Discoloration of the infiltrated surfaces was scored as no discoloration -1-, partial discoloration at the margins -2-, discoloration of the whole surface -3-. The marginal adaptation was recorded as follows: 1 Smooth transition (no detectable margins); 2 Sharp-edged margins.

All data were entered into a SPSS software (SPSS16.0 for windows, SPSS Inc. Chicago, IL, USA) for statistical analysis. Descriptive statistics and frequencies were performed regardless the type of data. The proportions of baseline and recalls data were compared by Friedman test. In all tests, p values below 0.05 were defined as statistically significant.

## Results

Ten patients were followed up clinically. The majority of the infiltrated lesions were located on permanent incisors (Table 1). From 21 lesions, three of them were categorized as E1, 10 were categorized as E2 and eight of them were noted as D1. The mean DMF-S of the sample was  $7.3 \pm 2.9$  corresponding to a DMF-T of  $4.1.8 \pm 2.2$ . Adolescents were given oral hygiene education and dietary counselling. Only patients under annual recall system were included in the study. All patients were instructed to use dental floss. Teeth which were proximally infiltrated did not exhibit dental plaque and gingival bleeding in most patients (Table 2). At annual re-

**Tablica 1.** Rasprostranjenost infiltriranih lezija prema vrsti zuba i površini  
**Table 1** Distribution of the infiltrated lesions according to tooth type and surface.

	N	%
Trajni incizivi (m) • Permanent incisors (m)	7	33.3
Trajni incizivi (d) • Permanent incisors (d)	8	38.1
Trajni premolari (m) • Permanent premolars (m)	3	14.3
trajni premolari (d) • Permanent premolars (d)	3	14.3

**Tablica 2.** Nakupljanje plaka, gingivalni status i klinička trajnost infiltrata prvi tjedan te nakon jedne, dvije, tri i četiri godine  
**Table 2** Plaque accumulation, gingival status and clinical duration of the infiltrations at the 1-week, 1, 2, 3 and 4 year recalls

USPHS Criteria	Kod • Code	1 tjedan • 1 week	1 godina • 1 year	2 godine • 2 years	3 godine • 3 years	4 godine • 4 years	P
		N (%)	N (%)	N (%)	N (%)	N (%)	
Plaque accumulation	1 no plaque	21 (100%)	19(90.5%)	20(95.3%)	21 (100%)	19(90.5%)	1.00
	2 mild	0	2 (9.5%)	1 (4.7%)	1 (4.7%)	2 (9.5%)	
	3 moderate	0	0	0	0	0	
	4 excessive	0	0	0	0	0	
Gingiva status	1 healthy	21 (100%)	21 (100%)	20(95.3%)	21 (100%)	21 (100%)	1.00
	2 bleeding	0	0	1 (4.7%)	0	0	
	3 swelling	0	0	0	0	0	
	4 excessive	0	0	0	0	0	
Discoloration	1 sound	21 (100%)	17 (81%)	17 (81%)	17 (81%)	17 (81%)	0.06
	2 partial discoloration	0	4 (19%)	4 (19%)	4 (19%)	4 (19%)	
	3 whole discoloration	0	0	0	0	0	
	4 excessive discoloration	0	0	0	0	0	
Marginal adaptation	1 smooth	21 (100%)	21 (100%)	21 (100%)	21 (100%)	21 (100%)	1.00
	2 sharp	0	0	0	0	0	

stantna. Gingivalni status također je ostao isti i nisu zabilježene promjene u obliku i konturama zuba. Promjena boje uočena je na četiri zuba (19 %) na pregledu nakon godine dana i nije se mijenjala tijekom sljedećih kontrola (tablica 2.) Rubna prilagođenost infiltrata bila je postojana i glatka u svim slučajevima tijekom svih vremenskih intervala. Nisu uočeni oštri rubovi. Nisu zabilježene statistički značajne razlike u zadanim parametrima tijekom četverogodišnjih pregleda ( $p > 0,005$ ). Radiološka procjena zagriznih (*bitewing*) snimki 21 infiltrirane lezije nije pokazala napredovanje ni jedne od njih (100 %) tijekom četverogodišnjih kontrola (slika 1.) Oralna higijena svih pacijenata bila je zadovoljavajuća.

## Rasprava

Epidemiološki podaci pokazuju da je u svijetu vrlo visoka rasprostranjenost karijesa na aproksimalnim površinama, što zahtijeva invazivni zahvat, kako na mliječnim tako i na trajnim zubima (14). Infiltracija karioznih lezija nov je, jednostavan pristup stabilizaciji napredovanja inicijalne nekavitirane aproksimalne lezije (15). U ovom istraživanju nije zabilježena ni jedna kavitacija. Samo dvoje kvalificiranih dječjih stomatologa obavljali su zahvate i pratili pacijente četiri uzastopne godine. Kod pacijenata obrađenih u ovom istraživanju nije zabilježen nastanak novih karioznih lezija.

Nedavno je zaključeno da su *rubni integritet* i boja važni čimbenici u procjeni kvalitete lateralnih kompozitnih ispuna te je stoga široko upotrebljavani USPHS kriterij prilagođen za minimalno invazivnu infiltracijsku tehniku kako bi se mogao upotrebljavati u njezinoj procjeni (16). U ovom istraživanju rezultati su pokazali da su infiltrirane lezije bile vrlo učinkovite jer tijekom pregleda nije zabilježeno nakupljanje plaka na njima, rubni gingivitis ili krvarenje nakon sondiranja. Ni jedan infiltrat nije bio izgubljen. Na radiološkim snimkama nije zabilježen rast karioznih lezija. Jedini problem koji se navodi kao neuspjeh infiltracije, u ovom je slučaju promjena boje infiltrata, što uzrokuje nezadovoljstvo pacijenta.

Autori ovog istraživanja zaključili su da je aproksimalna infiltracija učinkovita metoda za smanjenje napredovanja kariozne lezije. Naši rezultati u skladu su s ishodima dugoročnih istraživanja (17 – 18) u kojima je zabilježeno zaustavljanje karioznih lezija nakon aproksimalne infiltracije. Nedavno je istaknuto da infiltrati mogu potaknuti promjenu boje u ranim fazama, ali to se naknadno može promijeniti (19 – 20). U ovom istraživanju jedan je pacijent zatražio promjenu infiltrata u estetski ispun nakon završetka četverogodišnjih kontrolnih pregleda.

U ovom istraživanju sudjelovalo je nedovoljno ispitanika zato što četverogodišnje istraživanje zahtijeva i kontrolnu skupinu. Unatoč tomu zadovoljni smo rezultatima zbog visoke razine oralne higijene. U zaključku možemo reći da je aproksimalna infiltracija vrlo učinkovita profilaktička mjera kad je riječ o adolescentima.

## Sukob interesa:

Nije bilo sukoba interesa.

calls, plaque scores remained constantly. The gingival status remained steady and no difference in tooth shape and contour were detected. Discoloration was detected in four teeth (%19) in 1st year recall and was constant in annual intervals (Table 2). Marginal adaptation was proper and smooth in all cases in all time intervals. There were no sharp edges detected. There was no statistical difference in any parameters between any time intervals ( $p > 0.005$ ). The radiographic evaluation of the bitewing radiographs showed no progression. 21 lesions (100%) were followed from baseline to the 4-year recall (Figure 1). Overall oral hygiene of the patients was satisfactory.

## Discussion

Epidemiological data show that the prevalence of caries on proximal surfaces in need of surgical treatment is very high around the world, both in the primary and the permanent dentition (14). Caries infiltration stands to be a new, easy approach to stabilize the progression of initial, noncavitated proximal lesions (15). In the present study, no visible cavitation was included. Only two calibrated pediatric dentists applied the technique and followed the patients for four consecutive years. The patients controlled in the study did not present any new caries lesions.

Recently it was stated that 'marginal integrity and color match were always considered important factors to assess the quality of posterior composites and, therefore, the widely used USPHS criteria were adapted for the micro-invasive infiltration technique in order to allow a comparison with the infiltration' (16). In the present study regarding plaque accumulation, gingival status and clinical duration of the infiltrations, the results were totally efficient where infiltrants were plaque free, gingival tissue was healthy and there was no bleeding during controls. There was no loss of infiltrations. Regarding radiographs, there were no caries progressions detected. The present paper finds discoloration a problem where patient satisfaction may be a cause of infiltrate failure.

The present study considers proximal infiltration as an efficient way to reduce caries progression. These results are consistent with recent long term studies (17-18) where progression of proximal non-cavitated caries lesions was efficiently arrested with proximal infiltration. Recently it was stated that infiltrates may lead to discoloration in early stages but this position may be reduced in subsequent months (19-20). In the present study, at annual intervals one of the patients wished to have an esthetic dental filling at the end of four years.

The present study lacks a higher number of cases since a 4-year evaluation needs cooperative control patients. However, because of high oral hygiene quality, the results are satisfactory.

In conclusion, proximal infiltration is an effective prophylactic measure in adolescents.

## Conflict of interest

None declared

**Abstract**

**Aim:** Resin infiltration of proximal lesions is a new approach to stopping caries progression. Therefore, the aim of the present study was to evaluate four-year efficacy of proximal infiltrates in adolescents. **Materials and methods:** In ten adolescents, a total of 21 proximal infiltrates (ICON® (DMG, Germany) were applied to initial proximal lesions of permanent incisors and premolars according to the manufacturer's instruction. The clinical quality of resin infiltration was assessed at 1 week, 1, 2, 3 and 4 years after the treatment and the evaluation of the therapeutic effect was analyzed by radiographs. **Results:** Ten patients were followed up clinically for four years. The majority of the infiltrated lesions were located on permanent incisors. Teeth which were proximally infiltrated did not exhibit dental plaque and gingival bleeding in most cases. At annual recalls, plaque scores remained constant. The gingival status remained steady and no differences in tooth shape and contour were detected. Discoloration was detected in four teeth (19%) in 1st year recall and was constant at annual intervals. The radiographic evaluation of the bitewing radiographs showed no progression in 21 lesions (100%) from baseline to the 4-year recall. Overall oral hygiene of the patients was satisfactory. **Conclusion:** In conclusion, proximal infiltration is an effective prophylactic measure in adolescents.

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**Key words**

Dental Caries Activity Tests; Dental Marginal Adaptation; Dental Cements; Composite Resins; Dental Prophylaxis

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