

UDC: 615.46:616.314-7 ; 616.314-002-08

DOI: 10.2298/SGS1401030K

Indirect Pulp Capping Using Different Calcium Hydroxide Products – A Clinical Study

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SUMMARY

Introduction Indirect pulp capping is a therapeutic intervention in the treatment of deep carious lesion in order to stimulate odontoblasts to produce tertiary dentin using different biomaterials based mainly on calcium hydroxide. The aim of this study was to assess the effect of hard-setting (Dycal) and a suspension of calcium hydroxide (Calcipulp) in the treatment of deep carious lesion (caries profunda).

Materials and Methods Clinical study included 29 patients of both genders, age 16 to 40, and 45 teeth of different morphological groups with verified caries profunda using clinical and radiographic examination. After the cavity preparation, calcium hydroxide materials (Dycal or Calcipulp) were applied on the pulpal wall and cavities temporarily restored (phosphate cement) for the period of two months. After this period cavities were restored with composite materials and clinically observed during twelve months, with mandatory check-ups after three and six months.

Results Obtained results showed that indirect pulp capping using calcium hydroxide suspension (90.0%) was more successful than hard-setting material (84.0%), but with no statistically significant difference.

Conclusion Suspension and hard-setting calcium hydroxide were equally successful in the treatment of caries profunda.

Keywords: indirect pulp capping; caries profunda; suspension; hard-setting; calcium hydroxide

INTRODUCTION

Dental caries has been perhaps one of the most common diseases widely present in both children and adults [1, 2]. Due to complex etiology and pathogenesis of this disease, its successful treatment is still a significant problem for majority of dental practitioners since caries profunda has very close topographical relationship with pulp. To preserve pulp vitality and successfully treat caries profunda, timely and correct diagnosis, effective removal of carious dentin as well as the use of appropriate medications and adequate restoration of cavity are required [1, 3, 4, 5].

Medications used in the treatment of caries profunda should primarily act on the remaining bacteria but also stimulate odontoblasts to produce tertiary dentin. Calcium hydroxide preparations are still the most commonly used agents in the treatment of deep carious lesions. When applied on the pulpal wall they stimulate odontoblasts to produce reparative dentin as well as kill microorganisms remained in a thin layer of dentin close to the pulp [6, 7, 8]. The treatment protocol for caries profunda is not yet established. Some authors suggest removal of all carious dentin prior to the application of calcium hydroxide products whereas other groups advocate only partial removal of carious dentin [6, 8, 9]. Despite the use of great advances of modern dentistry and the number of avail-

able medications, the treatment of deep carious lesions is still a challenge.

The aim of this study was to assess the effect of hard-setting (Dycal) and a suspension of calcium hydroxide (Calcipulp) in the treatment of deep carious lesions (caries profunda).

MATERIALS AND METHODS

Clinical study included 29 patients of both genders, age 16 to 40 years and 45 teeth of different morphological groups with diagnosed caries profunda using clinical and radiographic examination. The study was conducted at the Faculty of Medicine in Banja Luka.

Caries profunda was considered as carious lesion with soft dentin causing sensitivity to thermal stimuli and affecting more than $\frac{3}{4}$ of the tooth crown with healthy gingiva around the tooth. A radiograph of each tooth was taken immediately prior to the treatment to check whether there is possible microperforation of the pulp. Dentin thickness between the bottom of the cavity and the pulp was recorded using a ruler. The inclusion criterion was softened dentin with the thickness on the pulpal wall less than 1 mm. Dental chart for each patient was created and personal data, status of teeth and informa-

tion about the medicament used, subjective and objective changes during the treatment were recorded. Each patient was informed about the therapeutic procedure and signed informed consent.

Therapeutic procedure included cavity preparation with maximal removal of softened dentine using slow handpiece and round burs and sharp excavators. Twenty three randomly selected teeth received hard-setting calcium hydroxide (Dycal, Dentsply) and twenty two teeth received a suspension of calcium hydroxide (Calcipulp, Septodont). All cavities were temporarily restored using phosphate cement for two months with periodic monitoring every 2 weeks.

After two months, calcium hydroxide was removed and cavities permanently restored using composite material and suitable adhesive system. Observation period was twelve months with mandatory check-ups after three and six months. During the observation period all subjective symptoms such as tooth sensitivity to various stimuli or pain were recorded. The status of restoration and possible fracture of the tooth or filling were recorded.

RESULTS

The treatment of caries profunda was performed in molars (23), incisors (14) and premolars (8). Average success rate of the treatment of caries profunda was 86.7%, while the failure was recorded in 13.3% of cases. After 12 months of the treatment successful outcome was registered in 91.3% of molars, 87.5% premolars and 78.6% incisors. The difference was not statistically significant (Table 1).

The average treatment success of indirect pulp capping after 12 months was 86.7%. A little higher rate was observed after use of suspension (90.0%) than hard-setting calcium hydroxide (84.0%). However, the difference was not statistically significant (Table 2).

DISCUSSION

Successful treatment of deep carious lesions requires timely and correct diagnosis, effective removal of carious dentin, the use of appropriate medications and adequate restoration of the cavity [1, 3, 4, 10]. Calcium hydroxide is probably one of the most extensively studied and used dental material in the treatment of diseased pulp. It stimulates the formation of reparative and sclerotic dentin, protects pulp from thermal stimuli and has an antibacterial effect [9, 11].

A tooth with diagnosed caries profunda has a great potential for successful treatment. There are various products based on calcium hydroxide recommended for pulp protection in deep cavities. Calcium hydroxide products are available as suspensions or hard-setting cements used by mixing the same amount of base and catalyst. The effect of different calcium hydroxide products is very similar. In contact with dentin, these products cause reduced fluid flow through dental tubules, peritubular mineralization,

Table 1. Outcome of caries profunda treatment with regards to the morphological group of teeth

Tabela 1. Ishod lečenja dubokog karijesa u odnosu na morfološku grupu zuba

Morphological group of teeth Morfološka grupa zuba	Successful treatment Uspešna terapija	Number of teeth (%) Broj zuba (%)
Incisors Sekutići (n=14)	Yes/Da	11 (78.6)
	No/Ne	3 (21.4)
Premolars Premolari (n=8)	Yes/Da	7 (87.5)
	No/Ne	1 (12.5)
Molars Molari (n=23)	Yes/Da	21 (91.3)
	No/Ne	2 (8.7)

Table 2. Outcome of caries profunda treatment with regards to the material used for indirect pulp capping

Tabela 2. Ishod lečenja dubokog karijesa u odnosu na korišćeni materijal za indirektno prekrivanje pulpe

Material Materijal	Successful treatment Uspešna terapija	Number of teeth (%) Broj zuba (%)
Calcipulp	Yes/Da	18 (90.0)
	No/Ne	2 (10.0)
Dycal	Yes/Da	21 (84.0)
	No/Ne	4 (16.0)

closure of dental tubules and stimulation of tertiary dentin formation [8, 9]. It is the fact that there is no reliable method to determine the degree of pulp inflammation in deep carious lesions. This is the main reason why successful treatment of caries profunda is still questionable [6].

In addition to material choice for indirect pulp capping, the outcome of the treatment of deep carious lesion depends on adequate removal of necrotic, diseased and demineralised dentin as well as the choice of material for permanent restoration. Numerous clinical studies have also confirmed that bond quality between restorative materials and hard dental tissue is one of the most important factors for successful outcome of indirect pulp capping [2, 8].

The outcome of caries profunda treatment in different morphological groups of teeth indicates high success rate of indirect pulp capping in all groups. This can be primarily explained by proper and timely diagnosis, adequate removal of infected dentin, proper choice of medications for indirect pulp capping and placement of satisfying restoration. Numerous clinical studies have also confirmed that the most important factor in the treatment of deep caries is the placement of proper restoration. Experimental studies in animals have shown that good marginal seal of restoration protected pulp integrity even if the carious lesion beneath was not completely cleaned [3, 12, 13].

Obtained results of the current study also confirmed high success rate regardless of the calcium hydroxide product used. This could be due to satisfactory carious dentin removal and temporary and subsequently permanent restoration placement that provided good marginal seal in all teeth [3, 6].

The results obtained in the current study are consistent with the results of Estrela et al. [14], who investigated the effect of several medications used in the treatment of deep carious lesions. They found that calcium hydroxide

paste had higher antimicrobial effect than MTA, Portland cement, Dycal and Sealapex against several species of bacteria (*Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Staphylococcus aureus*) and fungi (*Candida albicans*) after a two-day incubation period. The inhibition zone on BHI agar ranged from 6 to 9.5 mm and diffusion zone was 10-18 mm. Dycal showed neither inhibition nor diffusion zone indicating weak antimicrobial activity [14]. Parolia et al. [15] in their research on 36 premolars also confirmed results of previous authors. Dycal showed the weakest anti-inflammatory effect compared to propolis and MTA. The study was based on histological assessment of the inflammatory response in pulp treated with the three different preparations. In fact, propolis caused the greatest anti-inflammatory effect in pulp. Similar to these results were reported by Leye Benoist et al. [16], who studied the effect of Dycal and MTA on the formation of tertiary dentin. They measured the thickness of tertiary dentin in 60 teeth after indirect pulp capping with these medicaments and found better effect of MTA than Dycal. Modena et al. [8] investigated cytotoxic effects of calcium hydroxide, adhesive systems, composite and glass-ionomer cements in contact with pulp and found that only products based on calcium hydroxide had ability to stimulate odontoblasts to produce tertiary dentin. Ferracane et al. [10] confirmed that medicaments based on calcium hydroxide and MTA can stimulate release of bioactive proteins such as TGF- β 1, originally embedded in dentin matrix, and thereby promote formation of reparative dentine.

CONCLUSION

Suspension and hard-setting calcium hydroxide were equally successful in the treatment of caries profunda.

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Klinička ispitivanja indirektnog prekrivanja pulpe različitim preparatima na bazi kalcijum-hidroksida

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KRATAK SADRŽAJ

Uvod Indirektno prekrivanje pulpe je terapijski zahvat u lečenju dubokog karijesa radi stimulacije odontoblasta i proizvodnje tercijarnog dentina primenom različitih bioloških sredstava uglavnom na bazi kalcijum-hidroksida. Cilj ovog rada je bio da se klinički proveri dejstvo tvrdovezujućeg preparata (Dycal) i suspenzije kalcijum-hidroksida (Calcipulp) u lečenju dubokih karijesnih lezija.

Materijal i metode rada Kliničko istraživanje je obuhvatilo 29 ispitanika oba pola, starosne dobi od 16 do 40 godina, sa 45 zuba različitih morfoloških grupa, kod kojih je na osnovu anamneze i kliničkog i radiografskog pregleda dijagnostikovano duboki karijes. U preparisane kavitete nanoseni su preparati na bazi kalcijum-hidroksida (Dycal ili Calcipulp), a potom je kavitet zatvaran materijalom za privremeno zatvaranje (fosfatnim cementom) tokom dva meseca. Posle ovog perioda kaviteti su restaurisani kompozitnim materijalima i klinički opservirani tokom dvanaest meseci, uz obavezne kontrolne preglede posle tri meseca i šest meseci.

Rezultati Dobijeni rezultati su pokazali da je postupak indirektnog prekrivanja bio nešto uspešniji posle primene preparata na bazi kalcijum-hidroksida u vidu suspenzije (90,0%) nego posle primene tvrdovezujućeg preparata na bazi kalcijum-hidroksida (84,0%), ali bez statistički značajne razlike između grupa.

Zaključak Različiti preparati kalcijum-hidroksida (suspenzija i tvrdovezujući preparat) bili su podjednako uspešni u lečenju dubokog karijesa.

Ključne reči: indirektno prekrivanje pulpe; duboki karijes; suspenzija; tvrdovezujući; kalcijum-hidroksid

UVOD

Karijes je jedno od najrasprostranjenijih oboljenja usne duplje i široko je zastupljen kako kod dece, tako i kod odraslih [1, 2]. Zbog vrlo kompleksne etiologije i patogeneze ovog oboljenja, njegovo lečenje je i dalje značajan problem za većinu stomatologa praktičara s obzirom na to da duboki karijes ima vrlo blizak topografski odnos karijesne lezije prema pulpi. Za očuvanje vitaliteta pulpe i uspešno lečenje dubokog karijesa neophodna je pravovremena i pravilna dijagnoza, brzo i efikasno uklanjanje karijesno promenjenog dentina, kao osnovnog rezervoara mikroorganizama, primena odgovarajućih lekova i kvalitetna restauracija preparisanog kaviteta [1, 3, 4, 5].

Medikamentna sredstva koja se koriste u lečenju dubokog karijesa imaju zadatak, pre svega, da deluju na zaostale mikroorganizme, ali i da stimulišu odontoblaste na proizvodnju tercijarnog dentina. Preparati na bazi kalcijum-hidroksida su i dalje najčešće korišćena sredstva u terapiji dubokog karijesa. Aplikovani na dno preparisanog kaviteta, oni stimulišu odontoblaste na proizvodnju reparativnog dentina, ali deluju i antibakterijski na mikroorganizme u tankom sloju preostalog dentina prema pulpi [6, 7, 8]. Mišljenja autora o lečenju dubokog karijesa i danas su podeljena. Pojedini autori smatraju da je pre primene medikamentnih sredstava neophodno potpuno ukloniti sav karijesno promenjeni dentin, dok druga grupa zagovara pristup sa delimičnim uklanjanjem razmekšalog dentina i ostavljanja tankog sloja na dnu preparisanog kaviteta [6, 8, 9]. Bez obzira na veliki napredak savremene stomatologije, te veliki broj medikamentnih sredstava koji se danas koriste u terapiji karijesa, lečenje dubokog karijesa i dalje je složen i kompleksan postupak čiji uspeh zavisi od velikog broja faktora.

Cilj ovog rada je bio da se klinički proveri dejstvo tvrdovezujućeg preparata i suspenzije kalcijum-hidroksida u lečenju dubokih karijesnih lezija.

MATERIJAL I METODE RADA

Kliničko istraživanje je obuhvatilo 29 ispitanika oba pola, starosne dobi od 16 do 40 godina, sa 45 zuba različitih morfoloških grupa, kod kojih je na osnovu anamneze i kliničkog i radiografskog pregleda dijagnostikovano duboki karijes. Kliničko istraživanje je realizovano na Medicinskom fakultetu Univerziteta u Banjoj Luci.

Duboka lezija je podrazumevala karijes sa dosta razmekšalog dentina praćen osetljivošću na termičke nadražaje i koji je zahvatao više od tri četvrtine krunice zuba sa zdravom gingivom oko zuba. Svaki zub je neposredno pre lečenja radiografisan, čime je proveravano da li postoji eventualna mikroperforacija na dnu karijesne lezije. Potom je na svakom rendgenskom snimku zuba evidentirana debljina razmekšalog dentina pomoću mikrometarskog razmernika. Kriterijum za izbor zuba u istraživanju bila je debljina razmekšalog dentina na pulpnom zidu ispod 1 mm. Za evidentiranje dobijenih podataka napravljen je poseban karton za svakog pacijenta, gde su ubeleženi lični podaci, stanje zuba i precizni podaci o korišćenim lekovima i materijalima, odnosno o subjektivnim i objektivnim promenama tokom terapijskog protokola. Svaki ispitanik je bio upoznat s terapijskim postupkom, za koji je dao pisanu saglasnost.

Terapijski postupak je obuhvatio preparaciju kaviteta s maksimalnim uklanjanjem razmekšalog dentina pomoću okruglih

rotirajućih svrdala i oštrog ekskavatora. Metodom slučajnog izbora su u očišćene kavitete aplikovana sredstva na bazi kalcijum-hidroksida. Na 23 zuba je nanesen tvrdvezujući preparat Dycal (*Dentsply*), a na 22 zuba suspenzija Calcipulp (*Septodont*). Svi kaviteti su privremeno zatvarani fosfatnim cementom tokom dva meseca uz povremene kontrole svakih 14 dana.

Posle dva meseca iz kaviteta su uklonjeni privremeni ispun i pasta kalcijum-hidroksida, a zub je restaurisan kompozitnim materijalima i odgovarajućim adhezivnim sistemima. Opservacioni period toka lečenja bio je dvanaest meseci, uz obavezne kontrolne preglede posle tri meseca i šest meseci. Tokom perioda posmatranja beležena su eventualna subjektivna zapažanja pacijenata, kao što su osetljivost zuba na različite nadražaje i pojava bola, a kliničkim pregledom registrovano je stanje ispuna, pojava fraktura dela zuba ili dela ispuna i drugo.

REZULTATI

Analiza dobijenih rezultata je pokazala da je terapija dubokog karijesa najčešće realizovana kod molara (23 molara), potom kod sekutića (14 zuba), a najmanje kod premolara (osam zuba). Prosečni uspeh ishoda lečenja dubokog karijesa bio je 86,7%, dok je neuspeh zabeležen u 13,3% slučajeva. Posle 12 meseci uspešni ishod lečenja je utvrđen kod 91,3% molara, 87,5% premolara i 78,6% indirektno prekrivenih sekutića. Razlika u dobijenim rezultatima nije bila statistički značajna (Tabela 1).

Analiza dobijenih rezultata o uticaju materijala za indirektno prekrivanje na ishod terapije dubokog karijesa pokazala je da je prosečan uspeh lečenja posle 12 meseci bio 86,7%. Nešto uspešniji ishod zabeležen je nakon primene preparata na bazi kalcijum-hidroksida u vidu suspenzije (90,0%) nego posle primene tvrdvezujućeg preparata na bazi kalcijum-hidroksida (84,0%). Ni ovde razlika nije bila statistički značajna (Tabela 2).

DISKUSIJA

Za uspešno lečenje dubokog karijesa neophodni su pravovremena i pravilna dijagnoza, efikasno uklanjanje karijesno promenjenog dentina, kao osnovnog rezervoara mikroorganizama, primena odgovarajućih lekova i kvalitetna restauracija preparisanog kaviteta [1, 3, 4, 10]. Kalcijum-hidroksid je sigurno jedan od najviše proučavanih dentalnih materijala i koristi se u brojnim indikacijama za terapiju obolele pulpe. On stimuliše formiranje reparativnog i sklerotičnog dentina, štiti pulpu od termičkih nadražaja i poseduje antibakterijsko dejstvo [9, 11].

Obolela pulpa sa dijagnozom dubokog karijesa ima veliki potencijal za reparaciju. Postoji čitav niz preparata na bazi kalcijum-hidroksida koji se preporučuju za zaštitu najugroženijeg dela pulpe kod dubokih kaviteta. Preparati na bazi kalcijum-hidroksida se najčešće koriste u vidu suspenzije, odnosno tvrdvezujućeg cementa, koji se dobija mešanjem istih količina baze i katalizatora. Dejstvo na dentin tvrdvezujućih preparata i suspenzija na bazi kalcijum-hidroksida je vrlo sličan. Naime, u kontaktu sa dentinom ovi preparati dovode do smanjenog protoka tečnosti kroz dentinogene kanaliće, do peritubularne mineralizacije, sužavanja otvora dentogenih tubula, odnosno stimulišu odontoblaste na formiranje terciarnog dentina [8, 9]. Činjenica je da danas ne postoji nijedan način za procenu

stepena zapaljenja pulpe ispod dubokih karijesnih lezija. To je i osnovni razlog što je uspeh u lečenju ovih oboljenja uvek pod znakom pitanja [6].

Osim materijala za indirektno prekrivanje, na krajnji ishod lečenja dubokog karijesa utiče, pre svega, kvalitet uklanjanja nekrotičnog, obolelog i demineralizovanog dentina, kao i materijal za konačnu restauraciju obolelog zuba. Brojna klinička istraživanja su takođe potvrdila da je kvalitet veze materijala za tvrda zubna tkiva jedan od najvažnijih faktora za uspešan ishod lečenja dubokog karijesa primenom terapijske procedure indirektnog prekrivanja [2, 8].

Dobijeni rezultati o ishodu lečenja zuba sa dubokim karijesom u pogledu morfološke grupe zuba ukazuju na visok procenat uspešnosti terapijskog postupka indirektnog prekrivanja pulpe. Ovo bi se prvenstveno moglo objasniti tačnom i blagovremenom dijagnozom, adekvatnim uklanjanjem inficiranog dentina, pravilnim izborom lekova za indirektno prekrivanje, odnosno kvalitetno realizovanom restaurativnom procedurom. Brojna klinička istraživanja su takođe potvrdila da je najvažniji faktor u lečenju dubokog karijesa upravo pravilna restauracija zuba. Eksperimentalne studije na životinjama su pokazale da dobro rubno zatvaranje materijala može da očuva integritet pulpe čak i kada sav karijes nije potpuno uklonjen sa dna kaviteta [3, 12, 13].

Dobijeni rezultati su potvrdili visok stepen uspešnosti lečenja dubokog karijesa posle primene i suspenzije i tvrdvezujućeg preparata na bazi kalcijum-hidroksida. Razlog za to bi mogao ležati u činjenici da je prilikom uklanjanja karijesa evakuisan i sav inficirani dentin, odnosno da je privremeni ispun od fosfatnog cementa tokom dva meseca obezbeđivao dobro rubno zatvaranje, kao i kasnije aplikovan konačni ispun od kompozitnih materijala [3, 6].

Rezultati dobijeni našim istraživanjem su u skladu s nalazima istraživanja Estrele (*Estrela*) i saradnika [14], koji su ispitivali dejstvo nekoliko lekova koji se koriste u terapiji dubokog karijesa. Istražujući antimikrobni efekat MTA, Portland cementa, Dycal-a, paste na bazi kalcijum-hidroksida i Sealapeax-a na nekoliko vrsta bakterija (*Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Staphylococcus aureus*) i gljivicu (*Candida albicans*) inokulisanih na BIH agru, ustanovili su nakon dvodnevog inkubacionog perioda da je pasta na bazi kalcijum-hidroksida imala najveće antimikrobno dejstvo i najbolji terapijski učinak (izmerena zona inhibicije je bila 6–9,5 mm, a zona difuzije 10–18 mm). Rezultati za Dycal su pokazali da nije bilo ni zone inhibicije, niti zone difuzije, što je ukazalo na slabo antimikrobno dejstvo [14]. Parolija (*Parolia*) i saradnici [15] su u svome istraživanju na 36 premolara takođe potvrdili rezultate prethodnih autora. Ispitujući dejstvo preparata na bazi propolisa, MTA i Dycal-a na zapaljenu pulpu, uočili su da najslabiji antiinflamatorni efekat od navedenih medikamenata ima Dycal. Studija je bila zasnovana na histološkoj proceni inflamatornog odgovora pulpe tretirane trima različitim preparatima. Preparat na bazi propolisa je pokazao najveći antiinflamatorni učinak, dok je MTA imao veće antiinflamatorno dejstvo u odnosu na Dycal. Do sličnih rezultata došli su i Leje Benoa (*Leye Benoist*) i saradnici [16] istražujući uticaj Dycal-a i MTA na pulpu, odnosno na formiranje terciarnog dentina. Merenjem debljine novostvorenog dentina na 60 zuba koji su indirektno prekriveni pomenutim lekovima, zaključili su da je bolje terapijsko dejstvo postignuto primenom MTA nego pre-

paratom Dycal. Modena (*Modena*) i saradnici [8] su ispitivali citotoksična dejstva dentalnih materijala u kontaktu s pulpnim tkivom, kao što su kalcijum-hidroksid, adhezivni sistemi, kompoziti i glasjonomer-cementi. Utvrdili su da preparati na bazi kalcijum-hidroksida imaju sposobnost da stimulišu odontoblaste pulpe u stvaranju čvrste barijere, dok ostali preparati nisu imali ovo svojstvo. Ferakan (*Ferracane*) i saradnici [10] ističu da lekovi poput preparata na bazi kalcijum-hidroksida i MTA mogu da stimulišu oslobađanje bioaktivnih proteina, kao što

je TGF- β 1, prvobitno ugrađenih u dentinski matriks, te samim tim podstiču formiranje i reparativnog dentina.

ZAKLJUČAK

Različiti preparati kalcijum-hidroksida (suspenzija i tvrdvezujućí preparat) bili su podjednako uspešni u lečenju dubokog karijesa.