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Posterior Composite Restorations – Theoretical and Practical Teaching of Undergraduate Students in Serbia and Abroad

Vesna Miletić¹, Dušan Sakić², Igor Šupljeglav²

¹Department of Restorative Odontology and Endodontics, School of Dental Medicine, University of Belgrade, Belgrade, Serbia;

²School of Dental Medicine, University of Belgrade, Belgrade, Serbia

SUMMARY

Introduction Due to the educational process inertia based on textbook literature, teaching of undergraduate students in dental schools is often behind modern practice. From the aspect of minimally invasive dentistry, composites are materials of choice for the reconstruction of most lesions in posterior teeth. The objective of the study was to systematize data about theoretical and practical teaching of undergraduate students regarding the application of posterior resin composites in the world's dental schools and compare it with the data obtained from the School of Dental Medicine, University of Belgrade.

Material and Methods MEDLINE database was searched for articles based on keywords *dental education* and *posterior composites*. Only articles published in the last five years and those which used the same questionnaire were included in the study.

Results Data were analyzed for the dental schools from the UK and Ireland, Spain, Japan, United States and Canada. Increased theoretical and practical teaching of students regarding posterior composites is noted in most schools. The dominant contraindication for using resin composite is allergy to its ingredients. Rubber dam is the most common method of providing aseptic conditions and dry field in the world, whereas in our school it is used in negligible number of cases. In a number of schools, metal matrices and wooden wedges are recommended for the proximal cavity restoration. Glass-ionomer cement is commonly used as a liner. Polishing and finishing of restorations is performed in the same session in 90-100% of the schools except in Japan, where it is carried out after 24 hours.

Conclusion Theoretical and practical teaching of posterior composite restorations is increasing in the world's dental centers. It is necessary to harmonize teaching in our school with international trends in the use of rubber dam, certain aspects of cavity design and protocols for the treatment of deep caries lesions.

Keywords: composite; dental education; posterior teeth; restorative dentistry; students; undergraduate studies

INTRODUCTION

Contemporary knowledge in dentistry, as in most other areas, is transferred following the “top down” principle. The knowledge generated in academic centers from scientific research is transferred to the users, general practitioners through the continuous education, as well as to students, future practitioners, through undergraduate and graduate studies. In medical sciences the flow of scientific knowledge from academic centers to daily practice is measured in years [1]. At least two reasons have an impact on this phenomenon. The first reason is the need to confirm new knowledge through a number of “repetitions” or experimental studies of different researchers, before scientific truth is generally accepted. Even then, scientific truth has a temporary, not a permanent character and can be modified or even completely rejected in the light of new experimental findings and technological advances. Rarely, individual studies can contribute to great and rapid knowledge shift from academy to practice.

Another reason is the inertia of educational system based primarily on textbook literature. Textbooks adjust more slowly to developing science whereas scientific journals are more dynamic and more current due to more frequent “updates”. Leading scientific journals are commonly published monthly while new editions of textbooks are published after several years. Not only that students are exposed to outdated knowledge, they also develop a model of slow acceptance of new knowledge. Current undergraduate students will be practicing by mid 21st century. It is therefore important that they acquire up-to-date knowledge at the beginning of their professional career. Also, they need to become aware of continuous and rapid changes in their work field so they can quickly and easily adapt new knowledge to their practice. Although awareness of rapid development of science in modern society is more or less empirical, it should be professionally focused while critical thinking actively encouraged.

As a rule, the transfer of knowledge from academy to practice is faster than to education; therefore, there is a

trend of dental education lag behind modern practice. An example is found in posterior composite restorations. The study done by Wilson and Setcos [2] showed that 10 years after introducing posterior composite restorations into the dental practice in Western countries, education about this new practice was rare. In as many as 90% of schools, posterior composites were not taught whereas in the rest of schools teaching was mainly at preclinical level.

Even today, the problem of educational lag behind practice has not been changed. Contemporary knowledge suggests that composites possess adequate mechanical properties to be the material of choice for most cavities in posterior teeth. One of few contraindications is bruxism [3]. A retrospective study of Opdam et al. [4] showed that composite restorations lifetime is similar to amalgam. However, a recent study done by Lynch et al. [5] revealed that majority of dental practitioners in the UK and Ireland still consider amalgam as material of choice for posterior teeth restorations. Even though the current study confirmed that both theoretical and practical teaching of undergraduate students regarding composites has been significantly improved in the British and Irish dental schools in the last five years, it is clear that most of dental practitioners still work influenced by the knowledge acquired in dental school.

Current literature confirms that researchers are interested in theoretical and practical teaching of posterior composite restorations. Studies in different countries investigate trends at regular intervals [6, 7, 8], while similarly designed studies from different countries [2, 7-11] allow comparison and identification of global trends.

The aim of this study was to systematize data from several international dental centers about theoretical and practical teaching of undergraduate students on the application of posterior composite restorations and compare it with teaching at the School of Dental Medicine, University of Belgrade.

MATERIALS AND METHODS

In December 2012, MEDLINE database was searched for articles based on keywords *dental education* and *posterior composites*. Only articles published in the last five years in English in peer-reviewed international journals indexed in the Journal Citation Report and journals with impact

factors were taken into account. For easier comparison only studies which used surveys with the same questions were selected.

RESULTS

Of 34 studies found searching for two keywords, only five met given criteria. These five studies about composite restorations on posterior teeth were related to the teaching in dental schools in the UK and Ireland [5], Spain [12], Japan [13], United States and Canada [6].

The following aspects of theoretical and practical teaching were analyzed: (1) position of resin composite restorations in the curriculum (order and frequency of lectures and practice); (2) contraindications for posterior composite restorations; (3) methods for dry field control; (4) cavity design; (5) matrices and wedges; (6) protection of exposed dentin; (7) materials; (8) light sources; (9) polishing and finishing of restorations; (10) indirect restorations; and (11) cost of services when performed by students.

Tables 1–9 systematize data on certain theoretical and practical aspects of undergraduate teaching. Some schools indicated more than one answer; the difference to 100% can be attributed to the implementation of self-etch adhesives. Japan is the only country where 4% of dental schools use “plasma-arc” lamps.

In the next five years it is expected that the order of lectures “amalgam and then composite” would still exist in 23% of dental schools in the UK and Ireland. Average time of preclinical teaching dedicated to composites is now about equal the time devoted to amalgams. In the next five years it is expected that the time dedicated to teaching composites will be twice longer than the time dedicated to amalgams. In Spain, the order of teaching “composite and then amalgam” is expected in 47% of schools, 27% state and 100% of private dental schools. Japan does not expect any changes in the next five years regarding the order of lectures. In US and Canada it is projected that 55% of dental schools will continue to teach amalgam first, and then composite. Currently, longer time is dedicated to techniques for amalgam placement in pre-clinical teaching; however, it is expected to shorten time for teaching amalgam placement in favor of time for composite restorations placement. School of Dental Medicine

Table 1. Position of composite education in the curriculum (order of pre-clinical lectures and structure of clinical practice)

Tabela 1. Mesto edukacije o kompozitima u nastavi (redosled predavanja na pretklinici i struktura kliničke prakse)

Country Država	Order of lectures Redosled predavanja		Restorations in practical training Ispuni u praktičnom radu	
	Composite and then amalgam Kompozit pa amalgam	Amalgam and then composite Amalgam pa kompozit	Composite Kompozitni	Amalgam Amalgamski
UK and Ireland V. Britanija i Irska	59%	35%	55%	44%
Spain Španija	9% state, 25% private 9% državnih, 25% privatnih	91% state, 75% private 91% državnih, 75% privatnih	43%	26%
Japan Japan	65%	13%	45%	0% (metal inlays and alternatives) 0% (metalni inleji i alternativa)
USA and Canada SAD i Kanada	24.5%	73.5%	49%	48%

Table 2. Contraindications for the use of composites in occlusal and occluso-proximal cavities**Tabela 2.** Kontraindikacije za primenu kompozita na okluzalnim i okluzoproksimalnim kavitetima

Contraindications Kontraindikacije	UK and Ireland V. Britanija i Irska	Spain Španija	Japan Japan	USA and Canada SAD i Kanada	School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd
Allergy to composite ingredients Alergije na sastojke kompozitnih materijala	85%	87%	95%	94%	X
Impossibility of rubber dam placement Nemogućnost postavljanja koferdama	32%	46%	13%	76.5%	-
Replacement of large amalgam restorations Zamena velikih amalgamskih ispuna	20%	20%	26%	46%	X
Pathological teeth wear Patološko trošenje zuba	14%	27%	21%	44.5%	X
Low quality of enamel Loš kvalitet gleđi	3%	27%	19%	31%	-
Bucco-lingual width of occlusal cavity larger than 2/3 of intercuspal distance Bukolingvalna širina okluzalnog kaviteta prelazi 2/3 međukvržičnog rastojanja	14%	30%	52%	48%	-
Bucco-lingual width of occlusal cavity larger than 1/2 of intercuspal distance Bukolingvalna širina okluzalnog kaviteta prelazi 1/2 međukvržičnog rastojanja	0%	14%	6%	19.5%	-
History of postoperative sensitivity after restoration replacement Istorija postoperacione osetljivosti prilikom primene kompozita	40%	13%	6%	26.5%	-
Unjustified esthetic demands Nepostojeći estetski zahtevi	0%	13%	0%	12%	-
Poor oral hygiene Loša oralna higijena	38%	13%	28%	40%	X
Poor patient cooperation Loša saradnja pacijenta	47%	10%	35%	41%	X
Atypical diet Netipična ishrana	5%	7%	4%	13%	-
Bruxism Bruksizam	3%	27%	15%	36%	X
Subgingival margins Subgingivalni rub	35%	30%	20%	81.5%	-
Caries risk Rizik od karijesa	17%	27%	4%	45.5%	X

Table 3. Methods for moisture control used in the practical work of students**Tabela 3.** Metode za kontrolu vlage koje se koriste u praktičnom radu studenata

Moisture control Kontrola vlage	UK and Ireland V. Britanija i Irska	Spain Španija	Japan Japan	USA and Canada SAD i Kanada	School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd	
Use of rubber dam Primena koferdama	100% of cases 100% slučajeva	59%	/	4.5%	63%	/
	75% of cases 75% slučajeva	29.5%	87%	52%	37%	/
	50% of cases 50% slučajeva	6%	/	13%	/	/
	25% of cases 25% slučajeva	/	/	30.5%	/	/
	Not used Nije korišćen	6%	/	8.5%	/	X
Alternatives for moisture control Druge metode za kontrolu vlažnosti	Cotton rolls Vaterolne	64.5%	73%	100%	84%	X
	Dry guard Izolacioni splint	53%	18%	13%	73%	/
	Gauze Gaza	6%	18%	/	24%	/
	Aspirator Sisaljka	/	/	56.5%	/	X
	No alternatives Nema alternative	11.5%	26.5%	/	16%	/

Table 4. Cavity design**Tabela 4.** Oblikovanje kaviteta

Cavity design Oblikovanje kaviteta	UK and Ireland V. Britanija i Iraska	Spain Španija	Japan Japan	USA and Canada SAD i Kanada	School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd
Rounded internal line angles Kruškast oblik preparacije	47%	86%	95%	63%	X
Beveled margins Zakošavanje rubova	17%	67%	47%	47%	X
Slot preparation Slot tip preparacije	47%	73%	43%	67%	X
Exception of preventive extension Odstupanje od preventivne ekstenzije	58%	66%	100%	78%	X

Table 5. Application of various types of matrices and wedges in students' clinical work**Tabela 5.** Primena raznih vrsta matrica i kočića na studentskim vežbama

Matrices and wedges Matrice i kočići	UK and Ireland V. Britanija i Iraska	Spain Španija	Japan Japan	USA and Canada SAD i Kanada	School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd
Segmented metal matrix and wooden wedge Segmentirana metalna matrica i drveni kočić	88%	46%	86%	59%	X
Translucent matrix and translucent wedge Transluentna matrica i transludentni kočić	47%	53%	60%	18%	/
Translucent matrix and wooden wedge Transluentna matrica i drveni kočić	/	/	/	/	X
Circumferential metal matrix and wooden wedge Cirkumferentna metalna matrica i drveni kočić	47%	46%	17%	94%	X
Automatrix –self retained matrices Automatrix – samodržerice matrice	/	13%	/	/	/
Kerr Hawe matrices for posterior teeth and wooden wedge Ker-Havijeve matrice za bočne zube i drveni kočić	/	/	/	/	X

Table 6. Protection of exposed dentin before placing a composite filling**Tabela 6.** Zaštita eksponiranog dentina pre postavljanja kompozitnog ispuna

Country Država	Cavity depth Dubina kaviteta	Total-etch, no lining, adhesive Primena adheziva tehnikom totalnog nagrizanja, bez podloge	GIC without Ca(OH) ₂ Primena GJC bez Ca(OH) ₂	GIC with Ca(OH) ₂ Primena GJC sa Ca(OH) ₂
UK and Ireland V. Britanija i Iraska	Superficial Superficialni	88%	6%	
	Medium depth Srednje dubine	76%	18%	
	Deep Duboki	41%	23%	41%
Spain Španija	Superficial Superficialni	87%		
	Medium depth Srednje dubine	87%		
	Deep Duboki	47%	40%	13%
Japan Japan	Superficial Superficialni	100%		
	Medium depth Srednje dubine	91%	13%	
	Deep Duboki	35%	48%	48%
USA and Canada SAD i Kanada	Superficial Superficialni	90%	10%	
	Medium depth Srednje dubine	49%	49%	2%
	Deep Duboki	12%	61%	49%
School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd	Superficial Superficialni	X		
	Medium depth Srednje dubine	X	X	
	Deep Duboki			X

GIC – glass ionomer cement

GJC – glasjonomer-cement

Table 7. Composite materials used in students' clinical work**Tabela 7.** Kompozitni materijali koji se koriste na studentskim vežbama

Materials Materijali	UK and Ireland V. Britanija i Irska	Spain Španija	Japan Japan	USA and Canada SAD i Kanada	School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd
Microhybrid composite Mikrohibridni kompoziti	100%	33%	95%	13.4%*	X
Microhybrid composite with nano-fillers Mikrohibridni kompoziti sa nanopuniocima	/	41%	/	29.8%*	X
Composite with nano-fillers Kompoziti sa nanopuniocima	/	26%	/	/	/
Composite with micro-fillers Kompoziti sa mikropuniocima	/	/	4%	/	
Flowable composite Tečni kompoziti	/	/	13%	28.5%	X

* percentage of most frequently used composite

* procenat najčešće korišćenih kompozita

Table 8. Light sources used in students' clinical work**Tabela 8.** Svetlosni izvori koji se koriste u praktičnom radu studenata

Light polymerization Svetlosna polimerizacija	UK and Ireland V. Britanija i Irska	Spain Španija	Japan Japan	USA and Canada SAD i Kanada	School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd
Halogen lamps Halogene lampe	47%	47%	100%	51%	X
LED lamps LED lampe	88%	36%	61%		27%*

* percentage of Japanese schools that use both type of lamps

* procenat japanskih škola koje koriste obe vrste lampi

Table 9. Polishing and finishing of composite restorations**Tabela 9.** Završna obrada kompozitnih ispuna

Polishing and finishing Završna obrada	UK and Ireland V. Britanija i Irska	Spain Španija	Japan Japan	USA and Canada SAD i Kanada	School of Dental Medicine, Belgrade Stomatološki fakultet, Beograd
In the same visit U istoj seansi	94%	93%	13%	100%	X
After 24 hours Nakon 24 časa	/	7%	48%		39%*
Water cooling Vodeno hlađenje	53%	60%	74%	59%	/
Diamond burs Dijamanti	88%	80%	91%	73.5%	X
Discs Diskovi	82%	80%	/	23.5%	X
Stones Kamenčići		60%	/	46%	-
Finishing discs Tračice	88%	47%	95.5%	84.5%	X
Abrasive pastes Abrazivne paste	/	40%	/	100%	/

* percentage of Japanese schools that support both concepts of composite polishing and finishing

* procenat japanskih škola koje zastupaju oba koncepta završne obrade

in Belgrade had a practice to teach cavity preparation for amalgam first and then for composites, and in the second semester to do clinical teaching in the same order. However, this year composite restorations were done first followed by amalgam.

DISCUSSION

Traditional approach to cavity preparation and posterior amalgam restorations teaching followed by lectures about the modification of Black's principles for posterior composite restorations still exists in most schools in North America and Spain as well as in our country, whereas

the British-Irish and Japanese dental schools changed this approach in favor of composite. Interestingly, fewer private compared to public dental schools in Spain retain a traditional approach indicating faster adjustment of private schools to everyday practice in order to reach competitiveness.

Education about composites may have a negative effect on the perception of students, future dentists, that mechanical principles of restoration have advantage over modern principles of minimally invasive dentistry. Lynch et al. [5] reported that most of British dentists still consider amalgam as material of choice for posterior teeth. Teaching cavity preparation for composite restorations as a modification of classical Black's preparation puts clas-

sical preparation for amalgam in the position of “gold standard” due to the decades of domination. Actually, minimally invasive preparation should be modern “gold standard” for reconstruction of occlusal and proximal lesions in posterior teeth, and not an alternative to Black’s preparation [14]. Adhesive type of preparation has its own principles [15, 16] that should not be derived from Black’s but should be considered separately and in accordance with their position in modern dentistry.

The most common contraindication for composite restorations is sensitivity to certain ingredients. Moisture control is given much more importance in North American schools where impossibility of placing rubber dam and subgingival cavity edges more often contraindicated composites than in other surveyed schools. Despite the theoretical understanding of the importance of rubber dam to control moisture, in our school this is not a contraindication for the placement of composites. Subgingival cavity edges do not represent contraindication for composite restorations either; in such cases combined use of glass-ionomer cements and composites is recommended. Cavity size related to mechanical resistance of composites is listed as a contraindication in a number of North American and Japanese dental schools. This contraindication may be associated with lower resistance of composite to abrasion [17] compared to amalgam and enamel even though the addition of nanofillers significantly reduced vertical and total volumetric wear of composite [18]. Caries risk is a contraindication in nearly half of North American dental schools whereas in other countries caries risk is not a contraindication. This is somewhat surprising given that the most common reason for replacing composite restorations is caries [4, 19].

Moisture control using rubber dam is present in most of dental schools, while the most appropriate replacement are cotton rolls and a special type of insulation splint (so-called “dry guard”). Opdam et al. [19] followed a five-year success of composite restorations class I and II placed by students and concluded that acceptable annual failure was 2.8% (in most cases rubber dam was used). There has not been any similar study in our country to assess the effect of moisture control with cotton rolls and aspirator on the success of posterior composite restorations.

In terms of margin design, low percentage of schools teach beveling of cavity edges. Earlier recommendation for beveling was based on better adhesive and enamel bond due to greater microretentive area. However, it has been confirmed that beveling did not improve bonding [20]. In addition, there may be a thin layer of composite hinge on the inclined edge of enamel in areas that occlude with antagonists raising the possibility of marginal discoloration and need for restoration correction. When a composite filling should be corrected or replaced, a beveled marginal edge can make it difficult to identify cavity walls leading to unnecessary removal of healthy hard dental tissue [6].

In most schools metal matrices and wooden wedges are used for reconstruction of proximal portion of the cavity. In a significant percentage transparent matrices and wedges are used which reduces the need for subse-

quent polymerization after the removal of metal matrices. While there is no perfect system, some studies have shown that metal matrices and wooden wedges provide better adaptation of composites and stronger proximal contact [21, 22, 23].

Lining the cavity using glass-ionomer cements with or without medicament based on calcium hydroxide is commonly used in North American, and rarely in Spanish dental schools. In majority of surveyed dental schools, glass-ionomer lining is used in deep cavity only. In our school, combined use of calcium hydroxide and glass ionomer lining is accepted for dentin protection in deep cavity. Observed difference in theoretical teaching suggests that modern protocols are insufficient in the treatment of deep caries lesions. According to the former view, calcium hydroxide is a medicament of choice for the treatment of deep caries lesion [24]. However, recent literature review has confirmed no difference in quantitative pulp response after lining deep cavities with resin-modified glass ionomer cement and calcium hydroxide [25].

Between 90% and 100% dental schools accept the concept of immediate polishing and finishing of composite restorations, except in Japan, where nearly 50% of schools favor polishing and finishing after 24 hours. It is interesting that 40% of Japanese school support both concepts. Delayed polishing and finishing of composite restorations was previously explained by hygroscopic expansion of the material which compensates polymerization contraction. However, a recent study of Versluis et al. [26] confirmed that this compensatory effect takes up to 4 weeks to occur.

CONCLUSION

Education on posterior composite restorations has an important place in the curriculum of undergraduate studies in accordance with modern understanding of minimally invasive dentistry. Theoretical and practical aspects of education common to the most of surveyed dental schools in the world are related to reduction of contraindications, moisture control using rubber dam, adhesive type of cavity preparation with the exception of preventive extension, use of metallic matrices and wooden wedges, halogen and LED lamps, lining deep cavities and polishing and finishing of composite restorations in the same session. There is a need for harmonization of education in our school with international trends in the use of rubber dam, certain aspects of cavity design and protocols for the treatment of deep caries lesions.

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Kompozitni ispuni na bočnim zubima – teorijska i praktična nastava na osnovnim studijama stomatologije u svetu i kod nas

Vesna Miletić¹, Dušan Sakić², Igor Šupljeglav²

¹Klinika za bolesti zuba, Stomatološki fakultet, Univerzitet u Beogradu, Beograd, Srbija;

²Stomatološki fakultet, Univerzitet u Beogradu, Beograd, Srbija

KRATAK SADRŽAJ

Uvod Stomatološka edukacija na osnovnim studijama često zaostaje za savremenom praksom zbog tromosti našeg nastavnog procesa, koji je zasnovan na udžbeničkoj literaturi. S aspekta minimalno invazivne stomatologije, kompoziti su materijali izbora za rekonstrukciju većine lezija na bočnim zubima. Cilj rada je bio da se sistematizuju podaci iz svetskih centara o teorijskoj i praktičnoj edukaciji studenata osnovnih studija stomatologije o primeni kompozita u bočnoj regiji i uporede s edukacijom na Stomatološkom fakultetu Univerziteta u Beogradu.

Materijal i metode rada Pretraživanjem baze podataka MEDLINE prema ključnim rečima *dental education* i *posterior composites*, odabrana su istraživanja objavljena u poslednjih pet godina u kojima su korišćene istovetne ankete.

Rezultati Analizirani su podaci za stomatološke škole u Velikoj Britaniji i Irskoj, Španiji, Japanu, Sjedinjenim Američkim Državama i Kanadi. U većini škola uočava se trend povećanja teorijske i praktične obuke učenika. Jedina dominantna kontraindikacija je alergija na sastojke kompozitnih materijala. Koferdam je najčešća metoda obezbeđivanja aseptičnih uslova i suvog polja rada u svetu, dok se kod nas koristi u zanemarljivom broju slučajeva. Najveći broj škola zastupa metalne matrice i drvene kočice za proksimalne kavitete. Glasjonomer-cement se najčešće koristi za podlaganje dubokih kaviteta. Završna obrada ispuna u istoj seansi se primenjuje u 90–100% škola, osim u Japanu, gde se vrši i odložena obrada nakon 24 časa.

Zaključak Teorijska i praktična nastava o kompozitima u bočnoj regiji sve je češća u svetskim centrima. Potrebno je usklađivanje nastave kod nas s međunarodnim trendovima u pogledu primene koferdama, pojedinih aspekata dizajna kaviteta i protokola za lečenje dubokog karijesa.

Ključne reči: kompozit; dentalna edukacija; bočni zubi; restaurativna stomatologija; studenti; osnovne studije

UVOD

Savremeni tok znanja u stomatologiji, kao i većini drugih oblasti, odvija se po principu „od vrha na dole“ (engl. *top down*). Znanje stvoreno kroz naučnoistraživački rad u akademskim centrima prenosi se na korisnike – stomatologe praktičare kroz kontinuiranu edukaciju, a i na studente, buduće praktičare, kroz osnovne i postdiplomske studije. U medicinskim naukama tok naučnog saznanja od akademskog centra do svakodnevnih prakse meri se godinama [1]. Mogu se izdvojiti najmanje dva razloga koji utiču na ovu pojavu. Prvi razlog je neophodnost potvrde novog saznanja kroz veliki broj „ponavljanja“, odnosno eksperimentalnih studija različitih istraživača, pre nego što se proglašeno naučnom istinom. Čak i tada, naučna istina ima privremeni, a ne trajni, karakter i može se modifikovati ili čak potpuno odbaciti u svetlu novih eksperimentalnih saznanja i tehnološkog napretka. Vrlo retko pojedinačna istraživanja doprinose velikom i brzom pomaku u znanju od akademije do prakse.

Drugi razlog je tromost obrazovnog sistema, koji se zasniva pretežno na udžbeničkoj literaturi. Udžbenici se sporije prilagođavaju razvoju nauke od naučnih časopisa, koji su znatno dinamičniji i aktuelniji jer češće „ažuriraju“ podatke. Vodeći naučni časopisi obično izlaze na mesečnom nivou, dok se nova izdanja udžbenika objavljuju nakon nekoliko godina. Osim što do studenata mogu stići „prevaziđena“ znanja, ovakvim sistemom se preuzima i model sporog usvajanja novih saznanja. Studenti koji su danas na osnovnim studijama biće radno aktivni do sredine 21. veka. Zato je veoma važno da se steknu najsavremenija znanja na početku profesionalnog puta, ali i da se razvije svest o stalnim i brzim promenama u oblasti kojom se bave, kako bi mogli brže i lakše da ih prilagode svojoj praksi. Iako je svest o brzom razvoju nauke u savremenom društvu manje-više em-

pirijska, trebalo bi da bude i profesionalno usmerena, a kritičko mišljenje aktivno podržano.

Transfer znanja iz akademije je, po pravilu, brži u praksu nego u nastavu, pa postoji i trend zaostajanja stomatološke edukacije za savremenom praksom. Primer za to je restauracija bočnih zuba kompozitnim materijalima. Studija Vilsona (*Wilson*) i Setkosa (*Setcos*) [2] je pokazala da je tokom prvih desetak godina otkad je počela ova praksa u zapadnim zemljama nastava u svetu bila vrlo skromna. U čak 90% škola nije bilo predavanja o kompozitnim ispunima na bočnim zubima, dok je u preostalih školama ona bila pretežno na pretkliničkom nivou.

Problem zaostajanja edukacije za praksom nije se promenio ni do danas. Savremena saznanja ukazuju na to da kompoziti imaju odgovarajuća mehanička svojstva, da se mogu koristiti kao materijal izbora za većinu kaviteta na bočnim zubima, pri čemu izrazito opterećenje, poput bruksizma, predstavlja jednu od retkih preostalih kontraindikacija [3]. Retrospektivna studija Opdama (*Opdam*) i saradnika [4] pokazuje da je vek trajanja kompozitnih ispuna sličan amalgamskim. Ipak, nedavna studija Linča (*Lynch*) i saradnika [5] otkriva da većina stomatologa praktičara u Velikoj Britaniji i Irskoj i dalje smatra amalgam materijalom izbora za restauraciju bočnih zuba. Iako ova studija pokazuje da su i nastava i praktičan rad s kompozitima značajno napredovali u britanskim i irskim školama u poslednjih pet godina, jasno je da većina stomatologa praktičara još nije promenila shvatanja stečena na studijama.

Dosadašnja literatura pokazuje interesovanje istraživača za teorijsku i praktičnu nastavu o primeni kompozita na bočnim zubima. Studije u pojedinim zemljama prate trendove u pravilnim vremenskim intervalima [6, 7, 8], a slično osmišljene studije iz različitih zemalja [2, 7-11] omogućavaju poređenje i uočavanje globalnih trendova.

Cilj rada je bio da se sistematizuju podaci iz nekoliko svet-skih centara o teorijskoj i praktičnoj nastavi studenata osnov-nih studija stomatologije o primeni kompozita u bočnoj regiji i uporede s edukacijom na Stomatološkom fakultetu Univerziteta u Beogradu.

MATERIJAL I METODE RADA

U decembru 2012. pretražena je baza podataka MEDLINE pre-ma ključnim rečima *dental education* i *posterior composites*. Analizirana su samo istraživanja objavljena na engleskom je-ziku u poslednjih pet godina u međunarodnim časopisima s recenzijom koji su indeksirani u *Journal Citation Report*, od-nosno u časopisima s impakt-faktorom. Radi poređenja poda-taka, odabrana su istraživanja rađena u vidu ankete u kojima su postavljana ista pitanja.

REZULTATI

Od 34 studije dobijene pretraživanjem po dvema ključnim re-čima, pet je odgovaralo zadatim kriterijumima. Ove studije se odnose na edukaciju o postavljanju kompozita na bočne zube u školama u Velikoj Britaniji i Irskoj [5], Španiji [12], Japanu [13], Sjedinjenim Američkim Državama i Kanadi [6].

Traženi podaci se odnose na sledeće aspekte teorijske i prak-tične nastave: 1) pozicija edukacije o kompozitima u nastavi (redosled predavanja i učestalost prakse); 2) kontraindikacije za postavljanje kompozita u posteriornoj regiji; 3) metode za kontrolu vlage; 4) obrada kaviteta; 5) matrice i kočiči; 6) zaštita ekspaniranog dentina; 7) materijali; 8) svetlosni izvori; 9) završna obrada ispuna; 10) indirektni ispuni i 11) cene usluga na studentskim vežbama.

Tabele 1–9 sistematizuju podatke o pojedinim teorijskim ili praktičnim aspektima obrazovanja studenata. Neke škole su navele više odgovora; razlika do 100% se može pripisati primeni samonagrizajućih adheziva. Japan je jedina ispitivana zemlja gde se u 4% škola primenjuju i tzv. *plasma-arc* lampe.

U narednih pet godina u Velikoj Britaniji i Irskoj se očeku-je da će redosled predavanja o amalgamu pa o kompozitima i dalje postojati u 23% škola. Prosečno vreme na pretkliničkim predavanjima posvećeno kompozitima sada je približno vre-menu koje je posvećeno amalgamima. U narednih pet godina se očekuje da će vreme posvećeno predavanju o kompozitima u odnosu na vreme posvećeno amalgamima biti 2:1. U Španiji se redosled predavanja o kompozitima pa o amalgamu očekuje u 47% škola (27% državnih i 100% privatnih). U Japanu se ne očekuje promena aktuelnog redosleda predavanja u narednih pet godina. U SAD i Kanadi se predviđa da će 55% škola na-staviti s predavanjima prvo o amalgamu, a zatim o kompoziti-tima. Trenutno se više vremena posvećuje tehnikama postave amalgamskih ispuna na pretkliničkim vežbama, ali se očekuje skraćanje edukacije o amalgamu u korist vremena za vežbanje postavke kompozitnih ispuna. Na Stomatološkom fakultetu u Beogradu je do ove školske godine bila praksa da se prvo pre-daje preparacija kaviteta za amalgam, zatim za kompozit, a da se u drugom semestru sprovodi restauracija preparisanih zuba istim redom, dok je u ovoj školskoj godini rađena restauracija zuba prvo kompozitom, a nakon toga amalgamom.

DISKUSIJA

Tradicionalni pristup predavanju preparacije kaviteta i resta-uraciji bočnih zuba amalgamima iza kojih sledi predavanje o modifikaciji Blekovih principa za restauraciju bočnih zuba kompozitima i dalje postoji u većini škola u Severnoj Americi i Španiji, kao i kod nas, dok je u britanskim, irskim i japanskim školama ovaj pristup promenjen u korist kompozita. Zanimljivo je da je manje privatnih nego državnih škola u Španiji zadr-žalo tradicionalni pristup, što ukazuje na brže prilagođavanje privatnih škola svakodnevnjopraksi radi veće konkurentnosti.

Pozicija nastave o kompozitima u odnosu na amalgam mo-že loše uticati na shvatanje studenata, budućih stomatologa, da mehanički principi restauracije imaju prednost nad savremenim principima minimalno invazivne stomatologije. Na ovo ukazuje podatak Linča i saradnika [5] da većina britanskih stomatologa i dalje smatra amalgam materijalom izbora za bočne zube. Preda-vanje preparacije kaviteta za kompozit kao modifikacije klasične Blekove preparacije za amalgam stavlja klasičnu preparaciju u poziciju tzv. zlatnog standarda zbog višedecenijske dominacije. Međutim, zapravo je minimalno invazivna preparacija savremeni „zlatni standard“ za rekonstrukciju okluzalnih i proksimalnih lezija bočnih zuba, a ne alternativa klasičnoj Blekovojoj preparaciji [14]. Adhezivni tip preparacije ima svoje principe [15, 16], koje ne bi trebalo izvoditi iz Blekovih, već bi ih trebalo razmatrati odvo-jeno i u skladu s njihovim mestom u savremenoj stomatologiji.

Najčešća kontraindikacija za postavljanje kompozita je preosetljivost pacijenta na pojedine sastojke ovih materijala. Kontrolni vlage se pridaje znatno veći značaj u severnoamerič-kim školama, pa su tako nemogućnost postavljanja koferdama i subgingivalnih rubnih kaviteta znatno češće kontraindikacije u ovim nego u drugim anketiranim školama. Uprkos teorijskom shvatanju značaja koferdama u kontroli vlage kod nas, ovo nije kontraindikacija za postavljanje kompozita, kao ni subgingival-ni rub kaviteta, kada se preporučuje kombinovana primena gla-sjonomer-cementa (GJC) i kompozita. Veličina kaviteta koja bi se mogla dovesti u vezu s mehaničkom otpornošću kompozita navodi se kao kontraindikacija u većem broju severnoameričkih i japanskih škola. Ova kontraindikacija se može dovesti u vezu s manjom otpornošću kompozita na abraziju od amalgama [17] i naročito gledati, iako dodavanje nanopunilaca znatno smanju-je vertikalno i ukupno volumetrijsko trošenje kompozita [18]. Rizik od karijesa je kontraindikacija u skoro polovini severno-američkih škola, dok je u drugim zemljama ređi. Ovaj podatak je donekle neočekivan imajući u vidu da se kao najčešći razlog zamene kompozita navodi upravo karijes [4, 19].

Kontrola vlage koferdamom se navodi u nastavi u najvećem broju škola, a najprihvatljivije zamene su vaterolne i poseban tip izolacionog splinta (tzv. *dry guard*). Opdam (*Opdam*) i saradnici [19] su analizirali petogodišnji uspeh studenata u postavljanju kompozitnih ispuna I i II klase i zaključili da je prihvatljiv godi-šnji procenat neuspeha od 2,8%, pri čemu je u većini slučajeva korišćen koferdam. Kod nas ne postoji slična studija koja bi ukazala u kojoj meri kontrola vlage vaterolnoma i sisaljkom utiče na uspeh kompozitnih ispuna na bočnim zubima.

U pogledu oblikovanja kaviteta, najmanji procenat anketira-nih škola podržava zakošavanje rubova kaviteta. Ranije prepo-ruke za zakošavanje su isticale bolju vezu adheziva i gledati zbog veće mikroretentivne površine, ali je pokazano da zakošavanje ne utiče na kvalitet rubnog zaptivanja [20]. Osim toga, može do-

ći do odlamanja tankog sloja kompozita na zakošenom gleđnom rubu u zonama koje okludiraju s antagonistima, što povećava mogućnost marginalne diskoloracije i potrebu za korekcijom ispuna. Prilikom korekcije ili zamene ispuna zakošavanje gleđnog ruba može otežati identifikaciju pravih dimenzija kaviteta i dovesti do nepotrebnog uklanjanja zdravog zubnog tkiva [6].

U najvećem broju škola se za rekonstrukciju proksimalnih delova kaviteta koriste metalne matrice i drveni kočici. U znatnom procentu koriste se i transparentne matrice i kočici koji provode svetlost, čime se smanjuje potreba za naknadnim prosvetljavanjem nakon skidanja metalnih matrica. Iako ne postoji idealan sistem, istraživanja pokazuju da metalne matrice i drveni kočici omogućavaju bolju adaptaciju kompozita i jači proksimalni kontakt [21, 22, 23].

Podlaganje kaviteta sa GJC sa medikamentnom podlogom na bazi kalcijum-hidroksida ili bez nje najčešće se primenjuje u severnoameričkim, a najređe u španskim školama. U najvećem procentu anketiranih škola u svetu kod dubokih kaviteta se primenjuje samo podloga na bazi GJC. Kod nas se primenjuje protokol kombinovane kalcijum-hidroksidne i GJC zaštite dentina kod dubokih kaviteta. Uočene razlike u nastavi ukazuju na izostanak savremenog protokola za lečenje dubokog karijesa. Prema ranijem shvatanju, kalcijum-hidroksid je medikamentna podloga izbora u terapiji dubokih karijesa [24]. Međutim, nedavni pregled literature pokazao je da nema razlike u kvantitativnom odgovoru pulpe nakon podlaganja dubokih kaviteta GJC modifikovanim smolom i kalcijum-hidroksidom [25].

Između 90% i 100% anketiranih škola zastupa koncept neodložne završne obrade kompozitnih ispuna, osim u Japanu, gde se u skoro 50% škola favorizuje isključivo završna obrada nakon 24 časa. Zanimljivo je da 40% japanskih škola zastupa oba koncepta. Odložena završna obrada kompozitnog ispuna imala je svoje uporište u shvatanju o higroskopsnoj ekspanziji materijala kojom se kompenzuje polimerizaciona kontrakcija, međutim, nedavno istraživanje Versluija (*Versluis*) i saradnika [26] pokazuje da su za ovaj kompenzatorni efekat potrebne četiri nedelje.

ZAKLJUČAK

Predavanja o kompozitnim ispunima na bočnim zubima zauzimaju značajno mesto u nastavi osnovnih studija stomatologije u skladu sa savremenim shvatanjem minimalno invazivne stomatologije. Aspekti teorijske i praktične nastave koji su zajednički za najveći broj anketiranih škola u svetu odnose se na smanjivanje kontraindikacija, kontrolu vlage koferdamom, adhezivni tip preparacije kaviteta sa odstupanjem od preventivne ekstenzije, korišćenje metalnih matrica i drvenih kočica, halogenih i LED lampi, podlaganje dubokih kaviteta i završnu obradu ispuna u istoj seansi. Uočena je potreba za usklađivanjem nastavnog programa kod nas s međunarodnim trendovima u pogledu upotrebe koferdama, pojedinih aspekata obrade kaviteta i protokola za lečenje dubokog karijesa.