©Operative Dentistry, 2018, **43-6,** E273-E279

Direct Posterior Restorations: A 13-Year Survey of Teaching Trends and Use of Materials

A Zabrovsky • R Mahmoud • N Beyth • G Ben-Gal

Clinical Relevance

The increasing trend toward composite posterior restorations in an educational environment during a 13-year period may reflect movement toward an amalgam-free era.

SUMMARY

Objective: The study aimed to evaluate teaching trends and use of materials in direct posterior restorations during a 13-year period in an Israeli dental school.

Methods: Data registered in computerized files, relating to posterior restorations performed in the student clinic during the past 13 years (2004-2016), were collected. The restorative materials used (ie, amalgam vs composite), the type of tooth, and the number of surfaces restored were analyzed.

Results: Data analysis included 26,925 restorations performed during 13 years. The number of one-surface composite restorations increased from 54.7% (n=330) to 81.9% (n=873). Two-surface restorations increased from 33.3% (n=254) to 64.3% (n=721). The percentage of amalgam restorations in three-surface restorations decreased from 72.08% to 51.34% (n=173). Analysis of tooth type showed that in 2016, the number of composite restorations performed in premolars reached 80.87% (n=723) and in molars 63.50% (n=1035). The percentage of composite restorations in the mandible and the maxilla was virtually equal.

Conclusions: A clear trend in favor of composite resin restorations is evident in the 13-year survey and suggests a move toward an amalgam-free era.

†Asher Zabrovsky, DMD, Department of Prosthodontics, Hadassah School of Dental Medicine, Hebrew University, Jerusalem, Israel

*†Reema Mahmoud, Department of Prosthodontics, Hadassah School of Dental Medicine, Hebrew University, Jerusalem, Israel

Nurit Beyth, DMD, PhD, Department of Prosthodontics, Hadassah School of Dental Medicine, Hebrew University, Jerusalem, Israel

Gilad Ben-Gal, DMD, MSc, PhD, Department of Prosthodontics, Hadassah School of Dental Medicine, Hebrew University, Jerusalem, Israel

*Corresponding author: PO Box 12272, Jerusalem 91120 Israel; e-mail: reema.mahmoud@mail.huji.ac.il

†Authors contributed equally to this work.

DOI: 10.2341/17-361-C

INTRODUCTION

For more than 150 years, amalgam was the primary material used for dental restorations.[1] Today, composite resin materials, due to their esthetic and adhesive properties, are overtaking amalgam. The significant improvements in their physical properties in recent years have increased their prevalence, making them the material of choice in various clinical applications.[2]

Composite resin restorations were first used as anterior restorations. By the late 1990s, it was recommended that the principal use of direct composite resin restorations also include posterior restorations but be limited to permanent teeth with conservative small class 1 and class 2 restorations. This recommendation included preferably premolar teeth with little, if any, occlusal function, and mainly in patients maintaining a high standard of oral hygiene.[3]

Similar trends were observed in dental education. In the course of 25 years, there has been a steady increase in the use of composite resin materials for posterior tooth restoration. Whereas in the mid-1980s 90% of the dental school curricula did not include any consistent teaching of posterior composite resins, the percentage dropped to 4% in the late 1990s and to 0% by the early 2000s. Moreover, today some universities teach composite restoration before introducing amalgam.[4,5]

A comprehensive study compared three schools in three countries (Sweden, Wales, and Ireland) differing in their health care systems, financial remuneration schemes, and regulatory bodies. It found a direct relationship between the number of hours allocated to teaching the placement of posterior resin composites and the students' own perception of the adequacy of their learning combined with confidence in using these materials in clinical procedures. It is conceivable that students who are not confident in performing certain procedures may steer away from using these techniques in the future and may even remain incompetent in these specific procedures for some time.[4]

Guidelines of the Association for Dental Education in Europe maintained that new dentists must be competent "to restore the tooth appropriately to form, function and esthetics with different appropriate materials." Similarly, the UK General Dental Council recommends that new graduates should be qualified in "completing a wide range of procedures in restorative dentistry, including the use of amalgam alloy restorations and tooth-colored restorations."[6]

The present study aimed to evaluate current teaching trends, including the methods and materials used for direct restoration of posterior teeth and to evaluate whether the types of restoration performed by undergraduate students could serve as a predictive tool, with emphasis on the preference for composite materials over amalgam.

METHODS

All direct restorations performed by graduate students at the Hebrew University of Jerusalem's Hadassah School of Dental Medicine between 2004 and 2016 were registered and evaluated. The Faculty of Dental Medicine runs a six-year program in which students treat patients from the fourth year. Treatments were performed in the student clinic by students in their fourth, fifth, and sixth year of studies and supervised by experienced instructors. The duration of the clinic differs between clinical years. Fourth-year students have a six-hour clinic per week, while fifth- and sixth-year students have a 10- and 11- hour clinic, respectively.

Clinical decisions, including material choice, were supervised by instructors from the Department of Prosthodontics. The instructors' experience varied, ranging from one to 40 years.

Each treatment was documented in a computerized file. The medical records were signed by the instructors for every procedure for medical, legal, and monitoring purposes.

Data relating to tooth type, number of surfaces restored, and restoration material (amalgam/composite) were included.

For comparison, the types of restorative materials used were divided into three groups, according to the number of surfaces restored (one, two, and three), type of tooth (molars vs premolars), and jaw (maxilla vs mandible).

The data were arranged and displayed according to frequency tables and scatter charts.

RESULTS

A total of 26,925 restorations were performed in posterior teeth by undergraduate students at the Hadassah School of Dental Medicine from 2004 to 2016. During this 13-year period, the restorative material distribution was almost equal; that is, 49.54% (n=13,338) of the restorations performed were amalgam, and 50.46% (n=13,587) were composite resin. The shift in material choice may be seen in Figure 1. From 2004 to 2008, the material of choice was amalgam. From 2008 to 2012, a similar number of amalgam and composite restorations were performed. The year 2012 marked a turning point, composite resin becoming the dominant material, its use steadily rising.

The results were analyzed further on the basis of surface number (Figure 2). The predominance of one-surface composite restorations was clear, increasing from 54.7% (n=330) in 2004 to 81.9% (n=873) in 2016, whereas amalgam restorations dropped to 18.11% (n=193). The situation was slightly different

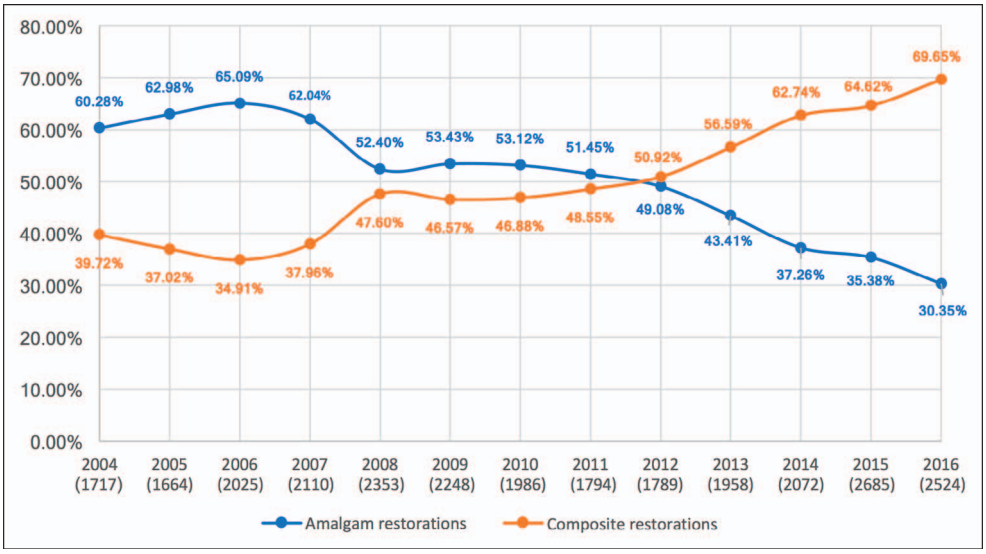


Figure 1. *Percentage of amalgam and composite restorations placed in posterior teeth by graduate students from 2004 to 2016. Numbers in parentheses indicate the number of restorations performed in the same year.*

regarding two-surface restorations. The number of amalgam restorations exceeded the number of composite restorations until 2013. After that, composite restorations were preferred over amalgam. The trend during the study period was clear: from one-third, 33.3% (n=254), of the two-surface restorations in 2004 to almost two-thirds, 64.3% (n=721), in 2016. Three-surface restorations showed a similar trend. Whereas in 2004 amalgam restorations were of significantly higher proportion than composite restorations, 72.08% vs 27.92% (n=253 vs n=98), in 2016 the percentage of amalgam restorations dropped to 51.34% (n=173).

The percentage of restorations in the premolar and molar groups is depicted in Figure 3. As can be seen, since 2010, at the expense of amalgam restorations, there has been a steady and constant increase in the percentage of composite restorations in premolars,

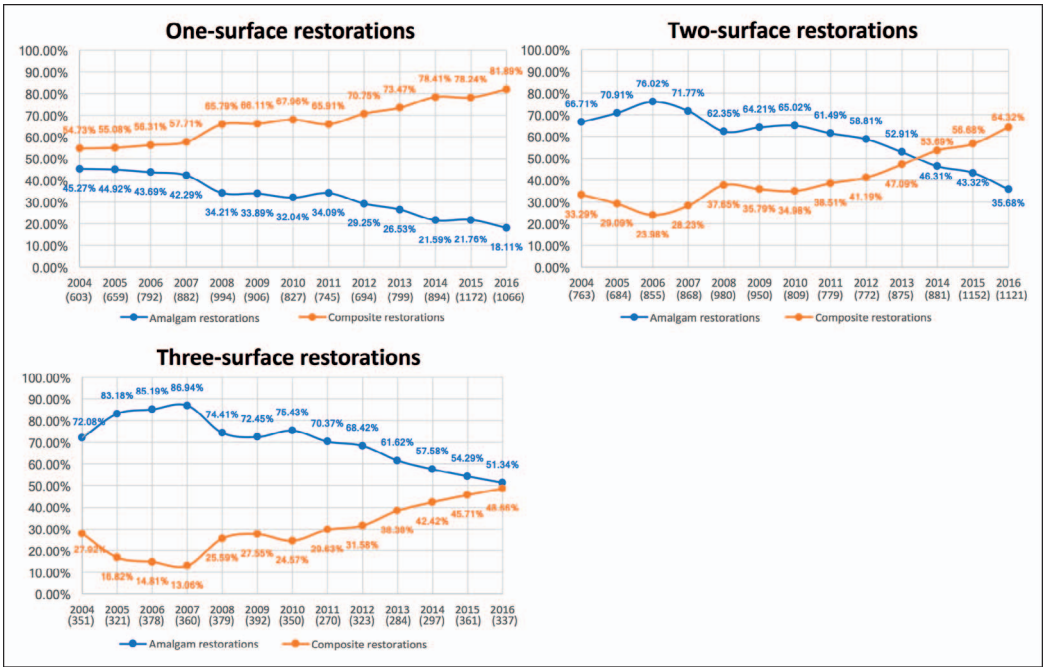


Figure 2. *Percentage of amalgam and composite restorations placed by undergraduate students from 2004 to 2016, divided by surface number.*

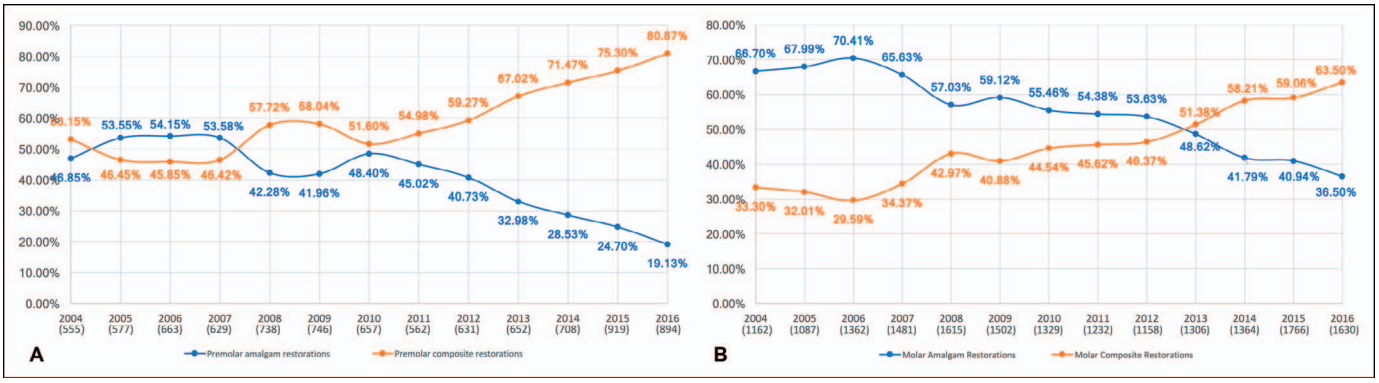


Figure 3. *(A): Percentage of amalgam and composite restorations placed in premolars by graduate students from 2004 to 2016. (B): Percentage of amalgam and composite restorations placed in molars by graduate students from 2004 to 2016.*

which by 2016 reached 80.87% (Figure 3A). In molars, as shown in Figure 3B, the percentage of amalgam restorations in 2004 was 66.70% (n=775) and that of composite restorations 33.30% (n=387). The shift toward composite restorations was gradual, the balance tilting to 63.5% (n = 1035) by 2016.

Restorations in relation to tooth location (first premolar, second premolar, first molar, second molar, and third molar) in both jaws showed a decreasing percentage of composite resin restorations with distal advance (Figure 4.)

A comparison between the maxilla and the mandible shows no noticeable differences between the trends (Figure 5.)

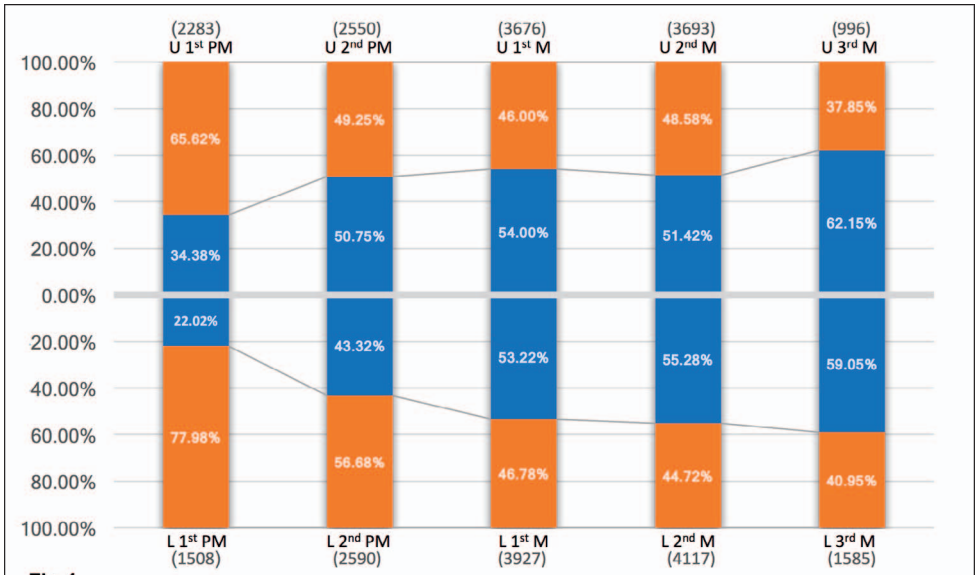
DISCUSSION

During the 13-year period of the study, composite resin became the dominant restorative material, the turning point evident in 2008. A growing transition toward composite resin restorations and a continuous reduction in amalgam shifted the ratio in favor of composite resin restorations in 2012 with a steady linear increase in one-, two-, and three-surface restorations, both in molars and in premolars, regardless of jaw. The shift in trend of the premolar group preceded that of the molar group. This is most likely related to esthetic considerations. Nonetheless, in three-surface restorations, slightly larger amounts of amalgam restorations were observed. It is likely that the overall trend, as in other worldwide dental faculties,[4,7] is adapting itself to the global trend toward an amalgam-free era.

The shift in treatment can be accounted for by numerous reasons. Composite materials have the ability to bond mechanically to the remaining tooth tissues, thereby strengthening the tooth's structure, restoring its original physical integrity and biomechanical properties.[9] Yet the main reason is most likely the increased awareness of the advantage of a minimally invasive approach in treating caries.[2,8] Recent developments in restorative dentistry show that the "extension for prevention" traditional guideline should be avoided and "minimally invasive dentistry" techniques promoted instead. This would avoid unnecessary excessive removal of healthy dental tissue as part of the treatment, leaving the restored teeth with a better overall prognosis and a greater ability to withstand loading in function.[1,8]

Another reason for the increase in composite use may be the sectional matrix systems that were introduced in 2008.[9] These include not only advanced anatomic wave-like wedges but also redesigned bands and grooved, V-shaped tine rings covered with silicone, allowing proper anatomy and tight proximal contact areas,[10] formerly considered problematic, in composite restorations.

Furthermore, the unceasing development of new materials and instruments, as well as improved composite resin material properties and performance, advocated more frequent use of such materials in the posterior area. For one, the new bulk-fill materials (like SDR from Dentsply and Filtek Bulk-Fill from 3M ESPE) probably contributed to favoring composite materials by reducing technique sensitivity[11] and procedure duration.[12] Other contributing factors may be newer, advanced adhesive systems, self-etch, and 10-methacryloyloxydecyl dihydrogen-phosphate–containing materials.[13] In addition, practitioners have had several years of experience with these materials, mastering the techniques required to handle them and perfect their use.[4] This probably also plays a major role in relying on composite materials and abandoning amalgam.



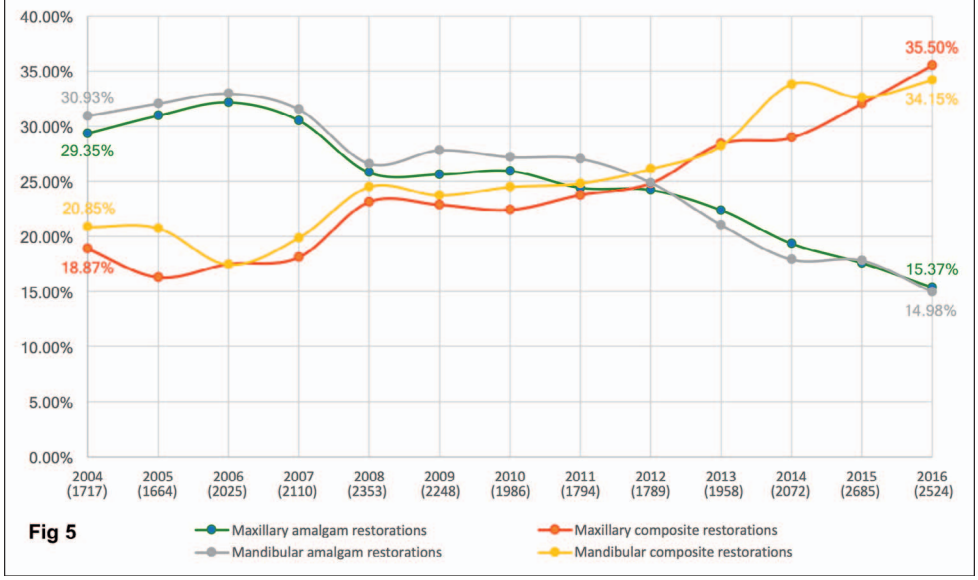


Figure 4. *Percentage of amalgam and composite restorations placed from 2004 to 2016 according to tooth order. U, upper; L, lower; M, molar; PM, premolar.*

Figure 5. *Percentage of amalgam and composite restorations placed in the maxilla and the mandible by graduate students from 2004 to 2016.*

Another contributing factor is the accumulating evidence that the overall performance of the posterior composite resin restorations is high[14] and at least comparable to that of amalgam restorations in many clinical settings.[15,16] Although the annual failure rate of composite restorations is still slightly higher than that of amalgam restorations, it is likely that in future studies the annual failure rate of posterior composite resins will be lower than those found in the present reviews.[14,17,18]

Patients also play an important role in these changes. The awareness and demand for an esthetic outcome, as well as the controversy over amalgam safety, have increased patient preference for composite resin restorations.

The amalgam debate is a driving force in the shift. Environmental pollution caused by medical waste containing mercury is a political issue in some countries. In Norway, for example, the use of amalgam has been banned from 2008,[19] and it appears that similar bills, based mostly on this environmental background, are being promoted in other European countries.[20] In 2013, the Minamata Convention (a World Health Organization committee dealing with the effects of mercury on the environment) committed itself to reducing and limiting the use and production of a range of mercury-containing products, including dental amalgam.[2]

In March 2017, the European Parliament agreed to prohibit by July 2018 the general use of amalgam

in children under 15 years of age and pregnant or breast-feeding women and required member states to draft national plans for phasing down the use of dental amalgam by July 2019, aiming to phase it out by 2022.[21]

These decisions, especially that of the Minamata Convention, have encouraged the production of alternatives to amalgam, causing an irrevocable change of what is customary in restorative dentistry,[1] as reflected also in the present study.

The present findings express the confidence and trust of clinical instructors in using composite resin materials to restore posterior teeth. Moreover, the young generation of instructors who has joined the more experienced ones may also have contributed to the increasing use of composite restorations due to their clear preference for esthetic materials.[22]

It is apparent that the change in trend observed over the past 13 years is on the rise. This change seems consistent with what is happening in other schools of dentistry worldwide.

Although few studies addressed the changes, data from 2011 in the United States showed that posterior composite restorations (for both one and two surfaces) exceeded amalgam restorations in number. In three- and four-surface restorations, similar to our study, amalgam was still the material of choice.[5] In Ireland and the United Kingdom, in the period between 2005 and 2010, a 33% drop in the number of amalgam restorations performed by students was recorded, whereas the number of posterior composite resin restorations increased by 180%.[7]

It is reasonable to assume that the change in trend observed within the faculty will be further reflected in the choices the young graduates will make. It should be emphasized that clinical instructors pass on their own practice methods to their students and that the educational experiences students accumulate throughout their studies contribute to their competency and determine the techniques they will use in their postgraduate practices as independent dentists. Students who graduated in 2008 and thereafter will be practicing dentistry for many decades in the future, making them the leading dentists of the global trend of the shift toward composite resin materials.

CONCLUSIONS

In conclusion, a clear trend in favor of composite resin restorations is evident in this 13-year survey. These results may suggest that the next generation of dentists will favor resin composite restoration, thus moving toward an amalgam-free era.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of approval of the Helsinki Ethics Committee. The approval code for this study is 0488-16-HMO.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article. This research did not receive any specific grant from funding agencies in the public, commercial, or nonprofit sectors.

(Accepted 8 March 2018)

REFERENCES

1. Lynch CD, & Wilson NH (2013) Managing the phase-down of amalgam: Part I. Educational and training issues *British Dental Journal* **215(3)** 109-113.
2. Alexander G, Hopcraft MS, Tyas MJ, & Wong RHK (2014) Dentists' restorative decision-making and implications for an "amalgamless" profession. Part 1: A review *Australian Dental Journal* **59(4)** 408-419.
3. Wilson NH, Dunne SM, & Gainsford ID (1997) Current materials and techniques for direct restorations in posterior teeth. Part 2: Resin composite systems *International Dental Journal* **47(4)** 185-193.
4. Lynch CF, Guillem SE, Nagrani B, Gilmour AS, & Ericson D (2010) Attitudes of some European dental undergraduate students to the placement of direct restorative materials in posterior teeth *Journal of Oral Rehabilitation* **37(12)** 916-926.
5. Rey R, Nimmo S, Childs GS, & Behar-Horenstein LS (2015) Curriculum time compared to clinical procedures in amalgam and composite posterior restorations in U.S. dental schools: A preliminary study *Journal of Dental Education* **79(3)** 331-336.
6. Plasschaert AJM, Holbrook WP, Delap E, Martinez C, & Walmsley AD (2005) Profile and competences for the graduating European *European Journal of Dental Education* **9(3)** 98-107.
7. Lynch CD, Frazier KB, McConnell RJ, Blum IR, & Wilson NH (2010) State-of-the-art techniques in operative dentistry: Contemporary teaching of posterior composites in UK and Irish dental schools *British Dental Journal* **209(3)** 129-136.
8. Wilson NH, & Lynch CD (2014) The teaching of posterior resin composites: Planning for the future based on 25 years of research *Journal of Dentistry* **42(3)** 503-516.
9. Owens BM, & Phebus JG (2016) An evidence-based review of dental matrix systems *General Dentistry* **64(5)** 64-70.
10. Freedman GA (2012) Posterior direct composites In: *Contemporary Esthetic Dentistry* Mosby, St Louis MO 244-266.
11. Van Dijken JWV, & Pallesen U (2014) A randomized controlled three year evaluation of bulk-filled posterior

resin restorations based on stress decreasing resin technology *Dental Materials* **30(9)** 245-251.

12. Flury S, Peutzfeldt A, & Lussi A (2014) Influence of increment thickness on microhardness and dentin bond strength of bulk fill resin composite *Dental Materials* **30(10)** 1104-1112.
13. The Dental Advisor (2012) 3M ESPE Scotchbond Universal Adhesive; Retrieved online May 13, 2017 from https://www.dentaladvisor.com/evaluations/3m-espe-scotchbond-universal-adhesive
14. Ástvaldsdóttir Á, Dagerhamn J, Van Dijken JWV, Naimi-Akbar A, Sandborgh-Englund G, Tranæus S, & Nilsson M (2015) Longevity of posterior resin composite restorations in adults—A systematic review *Journal of Dentistry* **43(8)** 934-954.
15. Opdam NJ, Bronkhorst EM, Roeters JM, & Loomans BA (2007) A retrospective clinical study on longevity of posterior composite and amalgam restorations *Dental Materials* **23(1)** 2-8.
16. Opdam NJ, Bronkhorst EM, Loomans BA, & Huysmans MC (2010) 12-year survival of composite vs. amalgam restorations *Journal of Dental Research* **89(10)** 1063-1067.
17. Demarco FF, Corrêa MB, Cenci MS, Moraes RR, & Opdam NJ (2012) Longevity of posterior composite restorations: Not only a matter of materials *Dental Materials* **28(1)** 87-101.
18. Moraschini V, Fai CK, Alto RM, & Dos Santos GO (2015) Amalgam and resin composite longevity of posterior restorations: A systematic review and meta-analysis *Journal of Dentistry* **43(9)** 1043-1050.
19. Norwegian Ministry of the Environment (2007) Amendment of regulations of 1 June 2004 no 922 relating to restrictions on the use of chemicals and other products hazardous to health and the environment (product regulations) *Oslo: Norwegian Ministry for the Environment*.
20. Lynch CD, & Wilson NH (2013) Managing the phase-down of amalgam: Part II. Implications for practising arrangements and lessons from Norway *British Dental Journal* **215(4)** 159-162.
21. Bourguignon D (2017) Mercury: Aligning EU legislation with Minamata. EPRS European Parliamentary Research Service. Retrieved online May 13, 2017 from: http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/595887/EPRS_BRI(2017)595887_EN.pdf
22. Ben-Gal G, & Weiss EI (2011) Trends in material choice for posterior restorations in an Israeli dental school: Composite resin versus amalgam *Journal of Dental Education* **75(12)** 1590-1595.