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Knowledge and utilization of direct pulp capping procedures among dentists

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Knowledge and utilization of direct pulp capping procedures among dentists

Introduction

Direct pulp capping (DPC) is a procedure in which a medicated dental material is placed on a pulp exposure during the excavation of caries. The main advantage of this procedure is to avoid performing more invasive procedures such as endodontic therapy or extraction, and to preserve tooth vitality. However, it has been a controversial subject when performed on adult patients with many clinicians favoring endodontic therapy as the most predictable treatment for permanent teeth. (1,2) Calcium hydroxide (CaOH) was first used in 1930 and shown to be successful for maintaining the vitality of the pulp after a pulp exposure. (3) The first clinical study evaluating CaOH for DPC was conducted in 1963 using primary teeth with a reported 85% pulpal survival rate. (4) Since then, CaOH has become the gold standard for DPC as it can induce teeth to create a protective dentinal bridge while healing from a carious pulp exposure. (5) However, a poor long-term success was noted in a evaluating the 5- and 10-year pulpal survival rates of DPC using CaOH with pulpal survival rates of 37% and 13% respectively. (6) The reasons for these failures may be due to the inability to create a long-term seal against bacteria, dissolution of the material over time, and an inability to induce a firm dentinal bridge. (7, 8, 9) There is a growing consensus that using CaOH for DPC after a carious pulp exposure is no longer preferred when compared to non-surgical root canal therapy (NSRCT), which demonstrates 10-year tooth survival rates of 74% (10). However, a tooth requires a full cuspal coverage restoration after NSRCT in order to prevent microleakage and fracture with additional treatment time and cost. (11) Furthermore, compared to a vital tooth, an endodontically treated tooth is two to three times more likely to fail due to a higher risk of fracture. (12)

In 1998, Mineral Trioxide Aggregate (MTA) was introduced to the dental market as ProRoot MTA with approval from the Food and Drug administration (FDA) as an endodontic repair material for perforations with the properties of high biocompatibility, and the ability to set in the presence of fluid. (13, 14) Research on pulpal responses between CaOH and MTA found that MTA was able to induce a thicker layer of a dentinal bridge but with less pulpal inflammation than CaOH. (15) Another study compared the outcomes between NSRCT and DPC with MTA and found no difference in the success rates at 5-years. (16) Two of the most widely used endodontic textbooks have recently incorporated an entire chapter on the topic of DPC with MTA, and suggested that MTA is now the gold standard for DPC. (17, 18) However, the main disadvantages of MTA are the long setting time that could take up to 24 hours, the potential for tooth discoloration, greater expense, and being difficult to handle. (19, 20) New pulp capping materials, calcium silicate material (CSM), have recently been introduced with Biodentine (Septodont, Saint-Maur-des- Fosse's, France) and EndoSequence BC RRM (Brasseler USA) the two most widely used in current clinical practice. The main advantages of CSM is that it provides similar properties as MTA but is easier to use with a faster setting time, and no tooth discoloration. Moreover, studies have shown similar long-term results between CSM and MTA in direct capping over mechanically exposed molar pulps. (21, 22)

Direct pulp capping could be a time-saving procedure for military members with multiple deep carious lesions as it will only require a single dental appointment to complete the treatment instead of multiple dental appointments when treating the tooth with conventional root canal therapy. (11) However, despite the recent studies showing a favorable outcome with DPC, there continues to be a decline in the number of DPC procedures being recorded across the US Army. (Table 1) The purpose of this study was to evaluate the attitudes, perceptions, and knowledge on direct pulp capping amongst military dentists at several locations in the U.S. and Canada.

Methods

A link to a web-based survey (see Appendix A - Survey) was e-mailed to dentists at Fort Benning, GA, Fort Bragg, NC, Fort Campbell, KY, and all Canadian Armed Forces dentists. Data was collected from August to October of 2019. The survey instrument included questions assessing each provider's clinical experience and dental specialty. Additionally, the survey was designed to elucidate experience and preferences regarding direct pulp capping on adult patients.
Descriptive statistics were used for frequency of responses and where appropriate cross-tabulations were applied. Multiple comparisons were accomplished using the Kruskal-Wallis test with Dunn-Bonferroni post-hoc comparisons used to elucidate significant results. A chi-square test of independence was used for pairwise comparisons except in cases where Fischer's exact test was substituted due to a frequency ≤5. The Shapiro-Wilk test was used to assess the normality of the data distribution for time to complete survey. Consequently, measures of central tendency and dispersion for time are reported as medians with associated interquartile ranges. Significance was declared at $P < 0.05$ for all tests. All data was analyzed by using SPSS version 25.0 (SPSS, Chicago, IL).

Results

In total, 133 individuals initiated the survey with 131 (98.5%) completing the survey. The two incomplete surveys were not included in the analysis. Excluding outliers, the median time to complete the survey among individuals who indicated that they have performed direct pulp capping was 4min 1sec (IQR 3:07 – 5:51).

The majority of respondents (n = 105; 80.2%) who completed the survey reported practicing dentistry for 10 years or less. Only 8 respondents (6.1%) indicated that they had practiced for more than 20 years. There was no observed difference in the proportional experience of individuals who had, and who had not, performed direct pulp capping, $P = 0.60$. In contrast, differences among respondents were noted with respect to dental specialty, $P < 0.01$. Among those with experience with direct pulp capping, 76.1% (n = 89) reported their specialty as general dentist. Conversely, among those without experience direct pulp capping, the proportion of general dentists was only 57.1% (n=8). Respondent characteristics are shown in Table 2.

For those respondents who indicated no prior history of direct pulp capping, a follow-up question inquired about the reason for not performing the procedure. The primary reason for not using the procedure was a lack of applicable cases (n = 9; 64.3%). Only two individuals cited concerns about the procedure being not as predictable as non-surgical root canal-therapy (NSRCT).

Among those who endorsed performing direct pulp capping, the majority (n = 107, 90.7%) indicated they did so on adult (≥18 years) patients. Less than 10% (n = 11, 9.3%) indicated that they had only performed the procedure in pediatric cases. There was no relationship between the number of years in practice and an individual's response. However, it should be noted that there was a relationship with regard to specialty. The majority (>90%) of general dentists, comprehensive dentists, and other specialties indicated they had performed direct pulp capping on adults. However, among endodontists only 55.6% (n = 5) indicated they had performed direct pulp capping on adults, $P < 0.01$.

When asked if they had performed direct pulp capping in the past year, roughly half (n = 61; 52.1%) of the respondents indicated they had. Conversely, 56 respondents (47.9%) indicated that they had not performed the procedure during the past year. Next, respondents were asked if they routinely performed pulp vitality testing prior to restoring deep carious lesions. Most respondents (n = 86; 73.5%) endorsed routine testing with only a quarter (n = 31; 26.5%) stating that it was not routine. Neither experience nor dental specialty affected individuals' responses to either question, all $P > 0.05$.

Respondents were also asked whether or not they provided follow-up for a patient after treating with direct pulp capping. Individuals' responses to this question was related to the number of years in practice, $P = 0.02$. Most (n = 74; 79.6%) of respondents with ≤10 years post-dental school endorsed providing follow-up care. In contrast, among those with >20 years in practice, only 37.5% (n = 3) provided follow-up care. No difference was found between different dental specialties, $P > 0.05$.

Regarding training, the majority of respondents (n = 92; 71.8%) indicated that they were trained to perform direct pulp capping using CaOH. Nearly half (n = 62; 47.3%) stated that they were trained to use mineral trioxide aggregate (MTA). Full training data by dental specialty is shown in Table 3. There was no difference between dental specialties with regard to the number of materials they were trained to use, $P = 0.61$. Similarly, when asked which material they preferred, no differences were observed by dental specialty. CaOH and MTA were equally preferred among respondents (n = 41; 35.0% and n=42; 35.9% respectively). Experience was not found to affect either material training or preference, both $P > 0.05$.

When provided with a scenario and asked about their preferred treatment plan, experience was again not a significant factor, $P > 0.05$. Treatment plans did differ by provider specialty ($P < 0.01$); however no dominant trends were evident. These treatment preferences are shown in Table 4. Finally, respondents were asked which factors would be most important to their decision to perform, or not perform, direct pulp capping on a deep carious lesion. The most common factors in performing the procedure were the provider's ability to preserve pulp vitality without the need of NSRCT (n = 37; 31.9%), if the tooth generates no pain on percussion or palpation (n=25; 21.6%), and if the pulp exposure is <1mm (n = 23; 19.7%). Reasons provided for being unwilling to perform direct pulp capping on a deep carious lesion included a periapical radiolucent lesion (n = 48; 41.0%) or negative response on cold test despite adjacent teeth having positive response to cold test (n = 32; 27.6%).

Discussion

DPC on carious pulp exposures is a procedure with the goal of maintaining the vitality of the pulp. It involves placing a biocompatible material on the exposed pulp, and a direct restoration. CaOH was considered a gold standard for several decades. (23) However, long term studies have shown that its effectiveness drops significantly after 5 to 10 years. (6) A new material, MTA was introduced in 1990s and has shown promising long-term results on maintaining vitality of the pulp. (24)

Results from this survey showed that about half of the respondents indicated that they haven't performed a DPC in the past year. A possible reason is that US dentists are more likely to perform NSRCT after a pulpal exposure with deep carious lesions compared to European and South American dentists. (25)

With regard to the training on DPC materials, 71.8% of the respondents reported receiving training with CaOH versus only 47.3% having training with MTA. (Table 3) This is to be expected since 85% of American dental undergraduate programs are still teaching CaOH as a gold standard for DPC in primary teeth. Training with MTA was rarely found in the undergraduate programs and was usually reserved for the graduate endodontic specialty programs. (26) Since most survey respondents were general practitioners, it is reasonable to expect most of the respondents would report training with CaOH rather than MTA.

When asked about the treatment preference in a scenario of a deep carious lesion on a permanent tooth, about 40% of the general dentists chose a direct restoration and DPC with MTA or CSM compared to 13% that chose NSRCT. (Table 4) This is in disagreement with 2 other similar surveys conducted in Wales and China which showed that general practitioners are more inclined to perform NSRCT when given a similar scenario. (27, 28), Endodontists in this survey selected DPC with MTA and NSRCT as the treatment of choice which is consistent with the results of a similar survey conducted in China. (28)

Respondents indicated the most important factors on whether to perform DPC was is to preserve pulp vitality without the need of NSRCT, no pain on percussion noted on the tooth, and a small pulp exposure (<1mm). These results concur with the main goals and determination of the success in DPC procedures from various long-term studies with MTA. (29, 30, 31) Maintaining pulp vitality is the primary goal of the DPC in order to avoid performing NSRCT since a tooth with a NSRCT is more susceptible to fracture. A study comparing the long-term survival of teeth treated with NSRCT showed NSRCT treated teeth were two to three time less likely to survive after 5 years compared to untreated and vital teeth. (32, 33) As for the second most chosen factor, the presence of percussion pain in a tooth with a deep carious lesion is often linked to a bacteria invasion to the apical periodontium, which is caused by a pulpal necrosis. (29) Therefore, studies and clinical trials have shown that when there is presence of percussion pain on a tooth with deep carious lesion, the likelihood of this tooth will need to have NSRCT increased by 35% as it has less chances to maintain vitality compare to a tooth without percussion pain.(24) As for the third most chosen factor, studies have shown that a small pulp exposure (<1mm) has higher chance to preserve pulp vitality (15, 31, 34) versus a pulpal exposure larger than 1mm. A study from Turkey, which followed 169 patients for 2 to 6 years after DPC with MTA, an exposure <1mm had a successful outcome of 92% compared to 75% with an exposure >1mm. (35) On the other hand, the presence of a periapical lesion is the main factor for our respondents to be unwilling to perform DPC, followed by a negative response to cold test. In a study which performed DPC on teeth with periapical lesions, the success rate was only noted on 3 cases out of 78, which is very low. (36) As for negative response to cold test, various studies have shown that the cold test is a reliable diagnostic tool for assessment of pulp vitality with a high sensitivity and specificity. (10, 11, 24, 29, 34) In the absence of a pulpal response to cold, studies with 5 years of follow-up have shown that the success dropped under the 60% range and with over 80% of teeth requiring NSRCT due to endodontic pain. (29) Therefore, it is critical to confirm the pulp vitality prior to perform DPC as it has a big impact on the long-term success.

In conclusion, DPC for deep carious lesions with MTA and CSM are considered a newer technique in dentistry. Although recent long-term studies on DPC with MTA/CSM have shown promising results, less than half of our respondents have chosen to use that treatment modality.

References:

(1) Ng YL, Mann V and Gulabivala K. Tooth survival following non-surgical root canal treatment: a systematic review of the literature. Int Endod J 2010; 43: 171–189.
(2) Langeland K. Management of the inflamed pulp associated with deep carious lesion. *J Endod* 1981;7 (4):169-181
(3) Stuart KG, Miller CH, Brown CE Jr, Newton CW. The comparative antimicrobial effect of calcium hydroxide. Oral Surg Oral Med Oral Pathol 1991; 72: 101-104.
(4) Sawusch R. Dycal capping of exposed pulps in primary teeth. J Dent Child 1963; 30: 141-149
(5) Schuurs AHB, Gruythuysen RJM,Wesselink PR (2000) Pulp capping with adhesive resin based composite versus calcium hydroxide: a review. Endodontics and Dental Traumatology 16, 240-50
(6) Barthel CR, Rosenkranz B, Leuenberg A, Roulet JF. Pulp capping of carious exposures: treatment outcome after 5 and 10 years: a retrospective study. J Endod 2000; 26: 525-528.
(7) Foreman PC, Barnes IE. A review of calcium hydroxide. *Int Endod J* 1990;23(6):283-297.
(8) Goracci G, Mori G. Scanning electron microscopic evaluation of resin-dentin and calcium hydroxide dentin interface with resin composite restorations. *Quintessence Int* 1996;27(2):129-135.
(9) Barnes IM, Kidd EA. Disappearing Dycal. *Br Dent J* 1979;147(5):111.
(10) Lumley, P.J., Lucarotti, P.S.K. and Burke, F.J.T. (2008), Ten-year outcome of root fillings in the General Dental Services in England and Wales. International Endodontic Journal, 41: 577-585.
(11) Schwendicke F, Stolpe M: Direct pulp capping after a carious exposure versus root canal treatment: A cost-effectiveness analysis. J Endod 40:1764-1770, 2014
(12) De Backer H, Van Maele G, Decock V, Van den Berghe L. Long-term survival of complete crowns, fixed dental prostheses, and cantilever fixed dental prostheses with posts and cores on root canal-treated teeth. *Int J Prosthodont*. 2007;20(3):229-234.
(13) Min KS, Park HJ, Lee SK, et al. Effect of mineral trioxide aggregate on dentin bridge formation and expression of dentin sialoprotein and heme oxygenase-1 in human dental pulp. *J Endod* 2008;34(6):666-670
(14) Tawil PZ, Duggan DJ, Galicia JC. Mineral trioxide aggregate (MTA): its history, composition, and clinical applications. Compend Contin Educ Dent. 2015 Apr;36(4):247-52
(15) Aeinehchi M, Eslami B, Ghanbariha M, Saffar AS. Mineral trioxide aggregate (MTA) and calcium hydroxide as pulp-capping agents in human teeth: a preliminary report. *Int Endod J*. 2003;36(3):225-231.
(16) Brodén J, Heimdal H, Josephsson O, Fransson H. Direct pulp capping versus root canal treatment in young permanent vital teeth with pulp exposure due to caries. A systematic review. *Am J Dent*. 2016;29(4):201-207.
(17) Hargreaves, Kenneth M., Stephen Cohen, and Louis H. Berman. *Cohen's Pathways of the Pulp*. St. Louis, Mo: Mosby Elsevier, 2015, 11th edition, chap 23
(18) Ingle, John Ide, Leif K. Bakland, J. Craig Baumgartner, and John Ide Ingle. *Ingle's Endodontics 7*. Hamilton, ON: BC Decker, 2019. Chap27
(19) Islam I, Chng HK, Yap AUJ. Comparison of the physical and mechanical properties of MTA and Portland cement. *J Endod* 2006;32(3):193-197.
(20) Dammaschke T, Gerth HUV, Züchner H, et al. Chemical and physical surface and bulk material characterization of white ProRoot MTA and two Portland cements. *Dent Mater* 2005; 21(8):731-738.
(21) Nowicka A, Lipski M, Parafiniuk M, Sporniak-Tutak K, Lichota D, Kosierkiewicz A, Kaczmarek W,Buczkowska-Radlińska J. Response of human dental pulp capped with biodentine and mineral trioxide aggregate. J Endod 2013; 39: 743-747.
(22) Parirokh M, Torabinejad M and Dummer PMH. Mineral trioxide aggregate and other bioactive endodontic cements: an updated overview - part I: vital pulp therapy. Int Endod J 2018; 51: 177–205.
(23) Baume LJ, Holz J. Long term clinical assessment of direct pulp capping. Int Dent J 1981;31:251–60.
(24) Bogen G, Kim JS, Bakland LK. Direct pulp capping with mineral trioxide aggregate: An observational study. *J Am Dent Assoc* 2008;139(3):305-315.
(25) V.V. Gordan, C.W. Garvan, M.W. Heft, J.L. Fellows, V. Qvist, D.B. Rindal, G.H. Gilbert, DPBRN Collaborative Group, Restorative treatment thresholds for interproximal primary caries based on radiographic images: findings from the Dental Practice-Based Research Network, Gen. Dent. 57 (2009) 654–663.
(26) Miles JP, Gluskin AH, Chambers D, Peters AO (2010) Pulp capping with mineral trioxide aggregate (MTA): a retrospective analysis of carious pulp exposures treated by undergraduate dental students. Oper Dent 35:20–28

(27) Chin JS, Thomas MB, Locke M, et al. A survey of dental practitioners in Wales to evaluate the management of deep carious lesions with vital pulp therapy in permanent teeth. Br Dent J 2016; 221: 331–338.
(28) Li M, Hu X, Li X, et al. Dentist-related factors influencing the use of vital pulp therapy: a survey among dental practitioners in China. *J Int Med Res*. 2019;47(6):2381-2393.
(29) Mente J, Hufnagel S, Leo M, et al. Treatment outcome of mineral trioxide aggregate or calcium hydroxide direct pulp capping: Long-term results. *J Endod* 2014;40(11):1746- 1751.
(30) Marques MS, Wesselink PR, Shemesh H. Outcome of Direct Pulp Capping with Mineral Trioxide Aggregate: A Prospective Study [published correction appears in J Endod. 2018 Jan;44(1):178]. *J Endod*. 2015;41(7):1026-1031
(31) Çalışkan MK, Güneri P. Prognostic factors in direct pulp capping with mineral trioxide aggregate or calcium hydroxide: 2- to 6-year follow-up. *Clin Oral Investig*. 2017;21(1):357-367.
(32) De Backer H, Van Maele G, Decock V, Van den Berghe L. Long-term survival of complete crowns, fixed dental prostheses, and cantilever fixed dental prostheses with posts and cores on root canal-treated teeth. *Int J Prosthodont*. 2007;20(3):229-234.
(33) Ng, Y.-L., Mann, V. and Gulabivala, K. (2010), Tooth survival following non-surgical root canal treatment: a systematic review of the literature. International Endodontic Journal, 43: 171-189.
(34) Cho S-Y, Seo D-G, Lee S-J, Lee J, Lee S-J, Jung II-Young (2013) Prognostic factors for clinical outcomes according to time after direct pulp capping. J Endod 39:327–331
(35) Daniele, Lucio. (2017). Mineral Trioxide Aggregate (MTA) direct pulp capping: 10 years clinical results. Giornale Italiano di Endodonzia. 31. 10.1016/j.gien.2017.04.003.
(36) Çalışkan MK, Güneri P. Prognostic factors in direct pulp capping with mineral trioxide aggregate or calcium hydroxide: 2- to 6-year follow-up. *Clin Oral Investig*. 2017;21(1):357-367.

Appendix A - Survey

1. Years practicing dentistry since dental school:
a. 1-10
b. 11-20
c. >20

2. What is your dental specialty:
a. General Dentist
b. Comprehensive Dentist
c. Endodontist
d. Other dental specialty

3. Have you ever performed direct pulp capping?
a. Yes
b. No

4. If you answered NO on question #3, why?
a. Not as predictable as non-surgical root canal therapy
b. It will affect the medical readiness of the Soldier for deployment
c. It will affect the ability of performing non-surgical root canal therapy in the future
d. No applicable cases
e. No patient acceptance

5. Have you performed direct pulp capping on adult (≥18 years of age)?
a. Yes
b. No

6. Have you performed direct pulp capping in the past year?
a. Yes
b. No

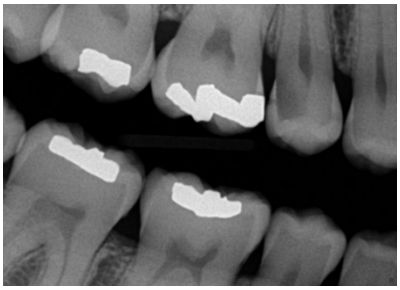
7. Do you routinely perform pulp vitality testing prior to restoring deep carious lesions?
a. Yes
b. No

8. Do you provide follow-up for the patient who has been treated with direct pulp capping?
a. Yes
b. No

9. Which dental materials have you been trained on for direct pulp capping?
a. Calcium hydroxide (CaOH)
b. Mineral trioxide aggregate (MTA)
c. Calcium silicate material (CSM)
d. Resin-modified glass ionomer (RMGI)
e. Others

10. Which dental materials do you prefer to use for direct pulp capping?
a. Calcium hydroxide (CaOH)
b. Mineral trioxide aggregate (MTA)
c. Calcium silicate material (CSM)
d. Resin-modified glass ionomer (RMGI)
e. Others
f. No preference

11. Which procedure would you chose to perform on tooth #4 given the following information? Patient is a 25 year old male. Tooth #4 is asymptomatic. Normal response to cold, no pain to percussion or palpation, and probing depths less than 3mm. However, upon caries excavation, an 1mm pulpal exposure is noted.



a. Direct restoration + a resin-modified glass ionomer liner
b. Direct restoration + Direct pulp capping with calcium hydroxide
c. Direct restoration + Direct pulp capping with mineral trioxide aggregate or calcium silicate material
d. Direct restoration + Partial pulpotomy with calcium hydroxide
e. Direct restoration + Partial pulpotomy with mineral trioxide aggregate or calcium silicate material
f. NSRCT #4
g. Other

12. Which factor is most important when deciding to perform direct pulp capping on a deep carious lesion?
a. Positive response on vitality test
b. Absence of periapical radiolucent lesion
c. Young patient: <30yo
d. Tooth is asymptomatic: no pain on percussion and palpation
e. Small pulp exposure: <1mm
f. Ability to preserve pulp vitality without the need of NSRCT
g. Other

13. Which factor is most likely to make you unwilling to perform direct pulp capping on a deep carious lesion?
a. Negative response on vitality test on the tooth to be treated, adjacent teeth have positive response on vitality test
b. Periapical radiolucent lesion
c. Tooth is symptomatic: pain on percussion and palpation
d. Large carious pulp exposure: >1mm
e. Failure to preserve pulp vitality due to past experience
f. Patient dental readiness: course, deployment
g. Other

Table 1. Number of direct pulp capping procedures across Army

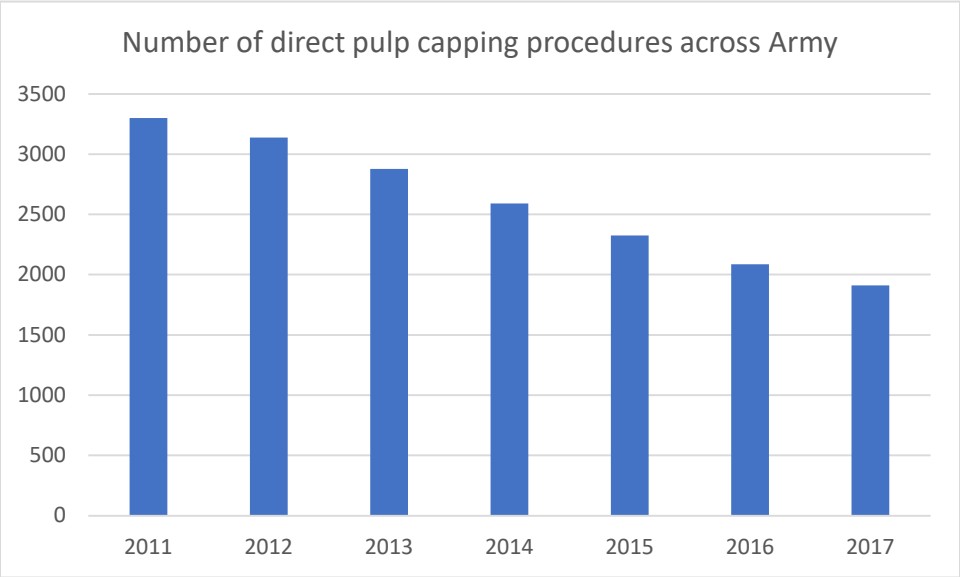


Table 2. Respondent Characteristics

	Total		Performed direct pulp capping				p
			Yes		No		
	n	%	n	%	n	%	
Years practicing dentistry							
1 – 10	105	80.2	93	79.5	12	85.7	
11 - 20	18	13.7	16	13.7	2	14.3	0.60
>20	8	6.1	8	6.8	0	0.0	
Dental specialty							
General dentist	97	74.0	89	76.1	8	57.1	
Comprehensive dentist	22	16.8	18	15.4	4	28.6	<0.01
Endodontist	9	6.9	9	7.7	0	0.0	
Other dental specialty	3	2.3	1	0.9	2	14.3	

Table 3. Materials Which Respondents Were Trained to Use in Direct Pulp Capping. n (%) [§]

Material	General Dentist	Comprehensive Dentist	Endodontist	Other	Total
Calcium Hydroxide	76 (45.2)	16 (39.0)	1 (7.1)	1 (100.0)	94 (71.8)
Mineral trioxide aggregate	41 (24.4)	13 (31.7)	8 (57.1)	0	62 (47.3)
Calcium silicate material	14 (8.3)	5 (12.2)	3 (21.4)	0	22 (16.8)
Resin-modified glass ionomer	35 (20.8)	6 (14.6)	1 (7.1)	0	42 (32.1)
Other	2 (1.2)	1 (2.4)	1 (7.1)	0	4 (3.1)

[§] Total response for each dental specialty may exceed number of respondents as each may have been trained on more than one material. Additionally, respondents who indicated they do not use direct pulp capping were not queried about training and so are not reflected here.

Table 4. Respondent Treatment Preferences Given Scenario A. n(%)

	General Dentist	Comprehensive Dentist	Endodontist	Other	Total
Direct restoration + a resin modified glass ionomer liner	8 (9.0)	2 (11.8)	0 (0.0)	0 (0.0)	10 (8.6)
Direct restoration + Direct pulp capping with CaOH	24 (27.0)	2 (11.8)	0 (0.0)	1 (100.0)	27 (23.3)
Direct restoration + Direct pulp capping with MTA or calcium silicate material	36 (40.4)	3 (17.6)	1 (11.1)	0 (0.0)	40 (34.5)
Direct restoration + Partial pulpotomy with MTA or calcium silicate material	5 (5.6)	2 (11.8)	3 (33.3)	0 (0.0)	10 (8.6)
Non-surgical root canal therapy	12 (13.5)	7 (41.2)	3 (33.3)	0 (0.0)	22 (19.0)
Other	4 (4.5)	1 (5.9)	2 (22.2)	0 (0.0)	7 (6.0)