Views From World Leaders in Operative Dentistry
June 10, 2022

STEPWISE REMOVAL : TREATMENT DECISION FACTORS, SUCCESS, AND COST-EFFECTIVENESS

Dr. Paula Ortega-Verdugo, DDS, MS, PhD
Restorative Dentistry Section UCLA School of Dentistry
portegaverd@g.ucla.edu

UCLA School of Dentistry

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Dr. Paula Ortega-Verdugo, DDS, MS, PhD
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Has no Conflict of Interest with any Organizations

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Outline

- Background Stepwise Removal (SW)
- Studies
  - Factors associated with stepwise removal
  - Cost-effectiveness analysis of stepwise vs. traditional caries removal
  - Study of acceptability of Caries Removal Techniques among Iowa dentists
- Clinical Recommendations

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Extensive caries lesions

***Lesion where its penetration depth is in the range of three fourths of the entire thickness of the dentin* with a radio dense zone separating the translucent zone from the pulp.**

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Deep dentin carious lesion
Healthy Pulp diagnosis

Non-Selective Removal to Hard Dentin	Stepwise Removal (SW)	Selective Removal to Soft Dentin (SE)
Complete removal of all carious tissue from a cavitated lesion	• Selective Removal on pulpal/axial walls • Two-step • Provisional restoration	• Selective Removal on pulpal/axial walls • One-step
Definitive restoration in same session	Pre-specified time interval	• Definitive restoration • Procedure is completed
	• Clinical Assessment • Residual caries removal Definitive restoration • Procedure is completed	

(Innes, et al. (2016) "Managing carious lesions: consensus recommendations on terminology." 2016)

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Primary Goal of Stepwise and Selective caries Removal is to Preserve Pulpal Health and avoid Pulp Exposure

Caveat: this is with the assumption that the tooth does not have pre-existing endodontic symptoms such as spontaneous pain, lingering sensitivity to cold etc.

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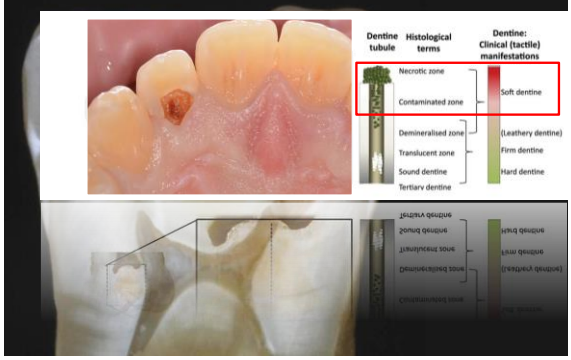
New Biological Understanding of Caries



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STEPWISE REMOVAL

- Comprehensive clinical and radiographic evaluation of the tooth before proceeding with SW
- Pulp sensibility tests (electric and thermal pulp testing)
- Lesion should be excluded if in the clinical evaluation there is any evidence of irreversible pulpitis symptoms
- Periapical radiograph with absence of periradicular pathosis

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STEPWISE REMOVAL

Two steps

- First step
  - Selective removal to soft dentin, carious tissue is left over the pulp
  - Peripheral dentin is prepared with a non-selective removal to hard dentin

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STEPWISE REMOVAL

First step:

- Selective removal to soft dentin, carious tissue is left over the pulp
- Peripheral dentin is prepared with a non-selective removal to hard dentin
- **Temporary restoration (e.g. RMGIs or glass hybrids)**

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STEPWISE REMOVAL

Second step

- Soft dentin is removed after 6 or more months until only firm dentin remains in the pulpoproximal areas.
- Selective removal to firm dentin
- Permanent restoration.
- Radiograph and Pulp vitality tests *

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Is the stepwise removal an effective procedure for the treatment of deep carious lesions?

What patient and clinical factors can influence having a successful stepwise procedure?

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Background

- SW has been shown to have a high percentage of success in the literature.
- Investigators of studies conducted in Sweden, Brazil, Denmark reported a high SW success, ranging from 74% to 92%*
- Investigators who conducted systematic reviews have found that alternatives caries removal methods decrease the risk of experiencing pulpal exposure when treating extensive dentin carious lesions.
- Although several systematic reviews and trials have studied incomplete caries removal, the investigators were unable to identify the most important predictors of success when treating DCL with SW.

*Bjørndal L, Thylstrup A. 1998; *Schwendicke* et al. *2018;* Bjørndal, Lars, et al. 2017; Innes N, et al. 2016

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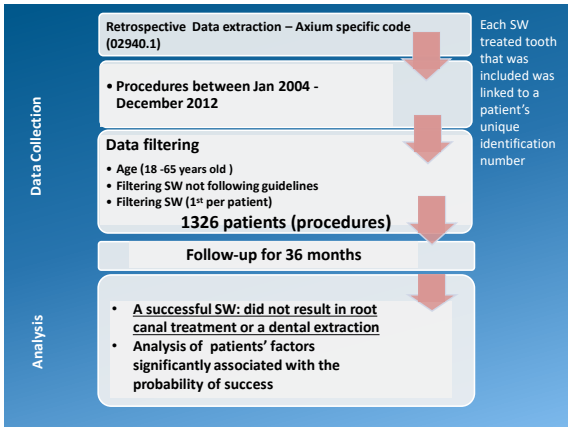

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Results

- Of 1,326 SWs, 626 procedures were reevaluated within the 36-month interval
- SWs completed at the UICOD from 2004 through 2012 had a 75% success rate at 3 years.
  - These findings are consistent with a randomized clinical trial completed in dental schools and public health services (74.1%) 1-year follow-up in adult teeth

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Bivariate analysis investigating the association between categorical covariates and success outcome within 36 months of the SW

Categorical Variable	Category	N	Success %	No Success %	P-value (χ^2 test)
Gender	Female	316	73.10	26.90	0.5890
	Male	309	76.05	23.94	
Tooth arch	Mandibular	280	74.64	25.36	0.9826
	Maxillary	346	74.57	25.43	
Dental Insurance Status	Dental insurance	257	75.10	24.90	0.5967
	Self-pay	289	75.43	24.57	
	Medicaid	80	70.00	30.00	
Reentry interval time	Early	212	64.15	35.85	<0.0001
	Optimal	219	84.47	15.52	
	Late	195	74.87	25.12	
Tooth type	Canines	43	72.09	27.90	0.4687
	Incisors	56	82.14	17.86	
	Molars	330	75.15	24.85	
	Premolars	197	72.08	27.92	
Miles	Near	302	79.14	20.86	0.0154
	Middle distance	251	68.53	31.48	
	Far	73	76.71	23.28	
Total number of surfaces treated	0	317	73.50	26.50	0.5802
	1	61	78.69	21.31	
	2	152	75.66	24.34	
	3	69	72.46	27.53	
	4	17	88.25	11.76	
	5	10	60	40	
Type of Provider	Dental student	461	77.00	22.99	0.0073
	Faculty	90	74.44	25.55	
	Resident	75	60.00	40.00	

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Logistic Regression Modeling

Outcome from multiple logistic regression modeling of the probability of success outcome within 36 months of the stepwise removal.

Variable	p-value	Odds Ratio Estimates	95% Wald Confidence Limits	
Reentry Interval	<0.0001			
Early vs. Optimal	<0.0001	0.338	0.210	0.545
Late vs. Optimal	0.0601	0.615	0.370	1.021
Age	0.0055	0.981	0.967	0.994

Patients that had an early reentry appointment were significantly less likely to show a successful treatment at follow-up compared to those who had the reentry at optimal time (5–9 months).

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Original Contributions

Retrospective analysis of factors associated with the success of stepwise excavation procedure in deep carious lesions

Paula Ortega-Verdugo, DDS, MS; John J. Warren, DDS, MS; Justine L. Kolker, DDS, MS, PhD; Knute D. Carter, PhD; Sandra Guzmán-Armstrong, DDS, MS; Manuel R. Gomez, DDS

Conclusion

- Treatment of deep carious lesions with SW is effective for pulp preservation and patient age may influence the outcome.
- SW can be successful regardless of patient age and clinicians should consider SW in treating DCLs.

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Is the stepwise removal procedure a more cost-effective procedure than the standard caries removal approach?

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Background

- If DCLs are not well managed, treatment expenses may be high as subsequent treatments of a carious tooth can be expensive.
- There is evidence that SW reduces costs while retaining vitality of teeth with extensive caries lesions
- Schwendicke et al. 2013* reported that incomplete excavation caries excavation could decrease costs and retaining vitality of teeth with extensive caries lesions.
  - Authors compared 3 interventions by using Markov models to simulate the treatment of molar teeth with deep caries lesions in 15-year-old patients.
- These studies were performed using health simulated economic models.

Schwendicke F, Stolpe M, Meyer-Lueckel H, Paris S, Dörfer C. 2013. Cost-effectiveness of one-and two-step incomplete and complete excavations. Journal of dental research

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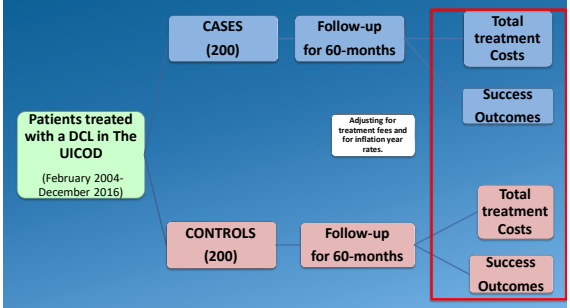
Cost-effectiveness Analysis Study design



*Data were retrospectively collected from electronic health records (EHRs) from the UICOD

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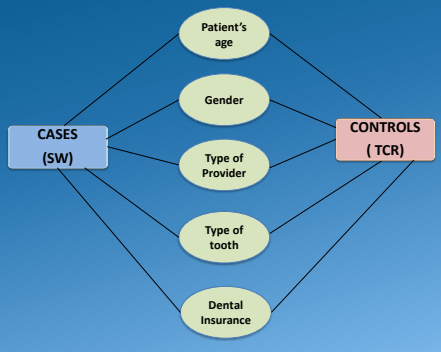
Matching cases & controls



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Material &Methods

Effectiveness measures

- *Tooth vitality* (absence of root canal treatments, tooth extraction and implants) during 5 years.
- *Tooth retention* (absence of tooth extraction or/and implant) during a 5 years period.

Costs

- Costs were measured in terms of SW treatment costs (procedures fees) of SW vs. the total cost of a TCR.

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Cost-effectiveness Analysis

Confidence Intervals for treatment average total costs in 5 years follow-up, effectiveness parameters, and Incremental Cost-Effectiveness Ratios (ICERs).

Caries removal method	Average Total costs*	Range of Cost estimates (Using 95% CI)		Tooth vitality (%)	Tooth Retention (%)
		Best case-scenario SW	Worst-case scenario SW		
SW	356.21	282.11	430.31	83.5%	91.0%
		Worst-case scenario TCR	Best-case scenario TCR		
TCR	989.61	1125.89	853.32	85.0%	97.0%
SW cost diff	-633.40	-843.78	-423.01		
ICER (DCost/De)	-		-	211.13	126.68

* Total costs were adjusted for faculty fees rates and discount rate adjusted by 2010 year
**Calculations were based on a n=200 sample size

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Sensitivity Analyses

Confidence Intervals for treatment average total costs in 5 years follow-up, effectiveness parameters, and Incremental Cost-Effectiveness Ratios (ICERs).

Caries removal method	Average Total costs*	Range of Cost estimates (Using 95% CI)		Tooth vitality (%)	Tooth Retention (%)
		Best case-scenario SW	Worst-case scenario SW		
SW	356.21	282.11	430.31	83.5%	91.0%
		Worst-case scenario TCR	Best-case scenario TCR		
TCR	989.61	1125.89	853.32	85.0%	97.0%
SW cost diff	-633.40	-843.78	-423.01		
ICER (DCost/De)	-		-	211.13	126.68

* Total costs were adjusted for faculty fees rates and discount rate adjusted by 2010 year
**Calculations were based on a n=200 sample size

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A Case-Control Study to assess the Cost-Effectiveness of the Stepwise Caries Removal Procedure

Conclusion

Our findings showed that SW is nearly as effective as TCR on keeping tooth vitality with significantly lower long-term costs compared to TCR.

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How willing are clinicians to perform less invasive caries removal methods, such as SW or SE?

What are the key factors that drive dentists' decisions when deciding to use a SW or a SE when treating an extensive carious lesion?

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Background

- Surveys from the USA, Brazil, Germany, and Sweden have revealed that clinicians do not have uniformity of treatment methods.
- In these surveys*, the majority of the surveyed dentists (50%-80%) selected *non-selective caries removal* to treat DCLs in permanent teeth

*Schwendicke F, et al. 2013; Weber CM et al. 2011; Koopaeei et al. 2017; Frisk F, et al. 2013; Oen et al. 2007

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Background

- All these studies* described the **hardness of the carious dentin tissue** **as** the main factor influencing clinicians' decisions
- There is not enough evidence regarding **specific factors** that influence dentists' decision in the U.S., particularly regarding deep caries lesions.

*Schwendicke F, et al. 2013; Weber CM et al. 2011; Koopaeei et al. 2017; Frisk F, et al. 2013; Oen et al. 2007

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Sequential Order of the survey procedure

Dentists licensed in Iowa were invited voluntarily to participate in a survey (from Iowa Dental Tracking System)

In September 2018, dentists (n=**1,434**) received a questionnaire with 18 clinical scenarios regarding DCLs Tx
Group SW and SE

The initial response of the survey was under 30%

A **reminder** was sent 2 weeks later, and after 4 weeks a **follow-up survey** was mailed

After 18 weeks, the survey was closed → 522 dentists responded

130 respondents showed no variation in their answers
non-traders

Both questionaries were analyzed independently trough
Conjoint Analysis

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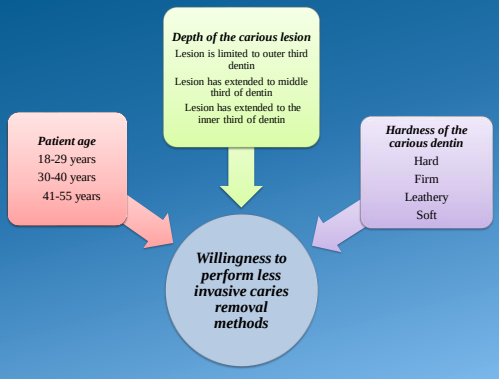
Study Conjoint Model



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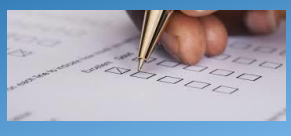
Results

- The survey had a **36.4%** response rate (n= 522) of 1,434 dentists
  - **130** respondents **showed zero variation among their ratings (non-traders)**
- Conjoint analysis was based on **366** responding dentists.



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Sample characteristics (n=522)

- The sample represented a diverse number of years of professional experience
- "What best describes the patient population in your practice?"
  - 62.9% reported working mainly with patients from "Middle Class"
  - 1.2% reported to be working with patients "Below Poverty"

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Sample characteristics (n=522)

- General dentists (79%) only 21% answered they had completed some type of postgraduate education program.
- 26% answered that they were "Very unlikely to use SW/SE" in all of the presented clinical scenarios.
- 1% answered that they were "Very likely to use SW/SR" with all of the eighteen clinical scenarios presented.

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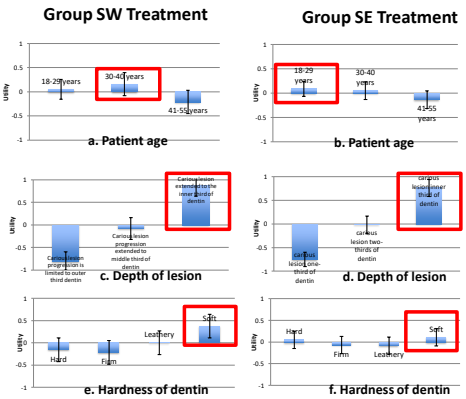

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Conjoint Model

"Patient who is between 30-40 years old that presents a soft caries lesion that extends to the inner third of dentin"

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Discussion

Distinct groups of dentists with differing preferences for factors when selecting a treatment for a deep carious lesion:

- 63 % who prioritized the carious lesion reaching the inner dentin
- 29% the most important factor to consider was that lesion would present soft dentin.
- 8% the most significant factor was that the carious lesion would be hard

There are no previous studies in the literature that have conducted similar analysis

26% who were not willing to perform less invasive methods for the DCL treatment in any of the clinical scenarios. Our findings are consistent with previous studies

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Discussion

- Type postgraduate education was a significant factor to determine non-traders and traders respondents (p=. 001)
- This might suggest that dentists who understand caries as a dynamic disease process would choose selective caries excavation methods more frequently than those who do not have this knowledge.

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Assessing the Acceptability of Alternative Caries Removal Techniques for treating Deep Carious Lesions: A Conjoint Survey among Dentists Practicing in a Midwestern American State

P. Ortega-Verdugo[2], J. Warren[1], G. Gaeth[1], K.D. Carter[1], E. Kateeb[3], J. Kolker[1], D. Shane[1]

Conclusions:

- Our survey showed that *depth of lesion* was the most important reason to select an alternative caries removal method.
- **The high proportion of dentists indicating they would never consider selective caries removal techniques suggests that these less expensive options are underutilized.**

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Recommendations for Private and Public Practice

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Recommendations for Private and Public Practice

- Less Invasive Caries approaches are based on the new biological understanding of caries.
- SW is a beneficial treatment for patients as it aims to preserve pulp vitality, but it also involves less treatment expenses.
- For deep lesions, in vital teeth stepwise removal is recommended.
- For restoring lesions, a strong temporary material is recommended, like Resin-modified glass ionomers (RMGIs) or glass hybrids.

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Recommendations for Private and Public Practice

- Dental insurances companies and government policy-makers should promote these less invasive approaches by creating professional incentives in public and private practice
- *This approach may raise the proportion of dentists performing selective caries removal methods instead of complete caries removal and can result in minimizing costs while providing the best patient care.*

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Thank You

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