

Stainless Steel Crown Success Using the Hall Technique: A Retrospective Study

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Abstract:

Purpose: This retrospective study evaluated the clinical and radiographic success of stainless steel crowns (SSC) used to restore carious lesions in primary molars placed using both the traditional technique (involving complete caries removal and tooth reduction prior to placement of the SSC) and the Hall technique (involving no caries removal, no crown preparation, and no local anesthesia prior to placement of the SSC). **Methods:** A retrospective chart review was conducted using the patient records at a private pediatric dental practice where the Hall technique had been introduced as an alternative treatment to traditional SSC starting in June 2010. The inclusion criteria were caries lesions on a primary molar with no clinical or radiographic evidence of pulpitis, necrosis, or abscess, and follow up of at least 6 months, or until failure. Restoration success was graded using a 4-scale criteria based on presence or loss of the SSC, and need or not for further treatment associated with pulpal pathology or secondary caries. Patient demographic information was collected and summarized. A Kaplan-Meier survival curve along with 95% confidence intervals was used to evaluate clinical success. **Results:** 65 out of 67 (97%) Hall technique crowns (mean observation time: 15 months, range 4-37) and 110 out of 117 (94%) traditional technique crowns (mean observation time: 53 months, range 4-119) were successful. **Conclusion:** Findings of this study show a similar success rate for SSC placed with either the traditional technique or the Hall technique.

Introduction:

Successfully managing dental caries in the pediatric population is a longstanding problem with multiple limitations including access to care, behavior management, and the need for definitive treatment until tooth exfoliation. In the US, dental caries is the most common unmet health need of children.[1] It is estimated that 20% of US children ages 2-5 years have untreated dental caries, and the untreated caries rate has not shown improvement over the past 20 years.[2] Proper treatment of carious primary molars is of particular importance because of the need to prevent oral infections, the role molars play in maintaining proper space in the arch for the permanent premolars, and for proper mastication.

Currently, stainless steel crowns (SSC), also known as pre-formed metal crowns, have shown significant clinical success and are considered a favorable restoration for two surface and larger carious lesions on primary molars.[3-5] The SSC is typically placed after traditional preparation, which for the purpose of this study will be defined as the following: administration of local anesthetic; adequate removal of tooth structure from the mesial, distal and occlusal surfaces; and complete removal of caries before luting the SSC with glass ionomer cement. The clinical failure of SSC is on average four times less than that of class II amalgam restorations.[5]

Though less technique sensitive than intracoronal restorations, stainless steel crowns placed using traditional tooth preparation still require administration of local anesthetic and multi-surface coronal reduction, potentially creating behavioral management problems. Behavior problems encountered by general dentists during simple restorative procedures often result in referral to pediatric dentists which limits access to care for those in communities without a pediatric dentist.[6] Uncooperative behavior of some children may also require that treatment be rendered using sedation or general anesthesia, which comes at an increased expense and risk to the patient. To better address the dental care needs of the child

population, practitioners must continue to explore alternative strategies for caries management and restorative treatment.

The Hall technique is a conservative alternative treatment of carious primary molars developed by Dr. Norna Hall in the 1980s. The Hall technique uses SSC to seal over carious lesions on primary molars using glass ionomer cement with no caries removal, no crown preparation, and no local anesthesia.[7] In a randomized, controlled clinical trial, SSC provided using the Hall technique have shown to outperform standard class II restorations provided by general dentists.[8] In addition to comparative restoration success, the Hall technique was preferred over traditional restorative techniques by the child, caregiver, and dentist.[9] The Hall technique provides dentists with a simple, definitive treatment that can be provided quickly in order to limit anxiety experienced by the patient.

Due to its non-invasive design, patient acceptance, and restoration longevity, the Hall technique may be an improved treatment option to increase access to care, decrease untreated caries rates, and provide a restoration that will allow for natural tooth exfoliation. While it has been shown that sealing primary carious molars with SSC and glass ionomer cement is successful, additional studies are needed to confirm the effectiveness compared to traditional SSC. The aim of this retrospective study was to evaluate the clinical and radiographic success of stainless steel crowns (SSC) used to restore carious lesions in primary molars placed using both the traditional technique and the Hall technique.

METHODS:

An Institutional Review Board approved, retrospective chart review of teeth treated with SSC was conducted using the patient records of a private-practice board-certified pediatric dentist in Indiana (USA). The records of all patients seen between April 1, 2008 to April 1, 2013 were audited (as Hall crowns started to be placed in 2010), and those with a history of having a SSC placed were considered for the study with date of SSC placement spanning March 2003 to March 2013. In 2010, the practitioner

utilized the Hall technique (Figure 1) as the primary technique unless there was a clinical requirement that would warrant a traditional preparation (such as possible pulpal involvement). For inclusion, patients must have had a caries lesion on a primary molar with no clinical or radiographic evidence of pulpitis, necrosis, and abscess, and chair side treatment of SSC provided using either the Hall Technique or a traditional preparation (Table 1). In this dental setting, primary molars receiving SSC (regardless of the technique) had caries lesions large enough that the clinician felt a Class I or II restoration was unlikely to be successful for the life expectancy of the tooth, yet not so extensive that the patient was experiencing or clinically demonstrating any signs or symptoms of irreversible pulpitis or pulp necrosis. SSC which served at any point as an abutment for a space maintainer were not included in the study.

All included teeth had clinical examination documentation at baseline (diagnosis of carious lesion) and at least six months' duration since placement of the SSC by the clinician or the clinician's expanded functions dental auxiliary. 184 SSC placed on 95 subjects met the inclusion criteria. Ten subjects receiving 12 SSC were not included due to inadequate follow up time. Clinical data analyzed included all baseline and recall intra oral examination records and radiographs, including any emergency exams. No additional clinical or radiographic information was collected.

Restoration success was graded based on the criteria originally defined by Innes et al (2006) (Table 2). Reported symptoms and discomfort that were recorded in the chart were included in the study's results; however, restoration failure was only defined as whether further treatment was required for the tooth. Radiographic findings included in the charts were re-analyzed independently of the practitioner's documentation by a single trained examiner.

Statistical Analysis:

Kaplan-Meier survival curves along with 95% confidence intervals were provided separately for each group (Hall technique and traditional preparation) using the statistical software package SAS version 9.3, SAS Institute Inc., Cary, North Carolina. Although some patients had multiple SSC, we ignored this correlation when calculating the confidence intervals. Demographic characteristics were summarized for each group: tooth, decayed, missing and filled teeth (dmft) at start, dmft change at end of observation period, gender and age.

Results:

Since June 2010, 34 children received a total of 67 SSC provided using the Hall Technique which were followed for an average of 15 months (range 4-37). From March 2003 to Dec 2012, 117 crowns were provided for 51 children using a traditional preparation and were followed for on average 53 months (4 to 119 months). The average±standard deviation age of these children at the time of treatment was 5.9±0.16 years for the Hall technique and 5.3±0.15 years for those treated using a traditional preparation with distributions shown in Figure 2. Routine bitewing radiographs were typically provided every 12-24 months. Radiographic follow up was present for two thirds of the Hall technique group. Of those without post-operative radiographs, 13% of those were due to discontinued follow up and 21% were not yet due for new routine radiographs. Three percent of the traditional preparation group did not have post-operative radiographs, all due to discontinued follow up.

During the duration of the study, 97% of SSC provided using the Hall technique were graded to be successful, while 94% of those provided using a traditional preparation were successful. Distribution of SSC success grading can be found in Table 3. The two observed failures of Hall technique crowns were both due to abscesses, with one causing symptoms at 5 months and the other identified during routine examination at 11 months. Of the Hall crowns graded to be successful, none caused painful symptoms as noted in the dental record and no follow up examinations were needed to evaluate symptoms. Five SSC

provided using a traditional preparation failed due to abscess or infection at an average time of 17 months (8, 8, 21, 23, 23 months). Two traditional crowns failed due to unretained SSC at 4 and 55 months, and both teeth were successfully treated with re-cementation of the SSC. Of the traditional SSC graded to be successful, one patient had problems with documented postoperative pain that did not require any further treatment.

Kaplan-Meier plots (Figure 3) show the step function form of the survival function. The step function drops at the particular time point that a restoration is graded as a failure. Survival probability remains unchanged when a restoration receives a grade of success, indicated as a tick on the graph. With a majority of the restorations and those with the longest follow-up being graded as a success, the survival function curve will not reach 0 and will remain at the probability of the previous interval. The blue-shaded and red-shaded areas around the survival curves represent the 95% pointwise confidence interval.

The survival function drops most steeply at the beginning of treatment for both techniques, suggesting that the hazard rates are highest after restoration during the first 0-2 years. The survival function of the traditional preparation group stabilizes after 2 years with only one failure after 24 months, suggesting that teeth treated with SSC may by in large remain successful after 2 years in service. Due to the infrequency of failures in both groups and the relatively small sample size, there is no statistical power to establish a statistically significant comparison between the two groups.

The demographic information was comparable for both groups. The average \pm standard deviation dmft at time of treatment was 6.2 ± 3.7 for the Hall technique group and 5.6 ± 2.5 for the traditional preparation group. The average \pm standard deviation change in the number of dmft was 1.0 ± 1.9 for the Hall technique and 2.5 ± 2.3 for the traditional preparation group with the difference attributed to the greater average length of observation of traditional preparation participants (Table 3). The average SSC size was 4 for Hall Technique, while the SSC size was not regularly recorded for a majority of the traditional

preparation crowns. Maxillary and mandibular primary first molars were the most commonly treated teeth for both groups (Table 4).

Discussion:

The results of this study are in line with previous studies showing that the Hall technique can result in a clinically sound restoration. The retrospective study by Innes et al. showed that a three year survival for SSC placed using the Hall technique was 73.4%. [7] A separate prospective study relying on multiple clinicians showed a survival of 96.2% after a minimum of 23 months of follow up [8] and 92% at 48 month minimal follow up. [10] The survival seen in this study after 15 months is in line with these previous results, and it is at or exceeding the success of all other materials used for restoring primary molars at 1-2 years follow-up, [11-13] A review of class II restoration longevity found mean annual failure rates of 7.6% for alloys, 13.9% for glass ionomer cement, 4.2% for resin modified glass ionomer, and 5.9% for composite restorations [11]. Some caution should be made in comparing these results to previous studies using the Hall technique, since in this practice setting, in the event of tight contacts, the clinician would provide a proximal slice to permit easier seating of the SSC. In contrast, the published Hall technique recommends use of an orthodontic separator to allow for physiologic movement of the teeth to permit crown seating without any proximal reduction. [7] However, even accounting for this change, treatment was able to be rendered in one appointment, without the need for local anesthesia, and with no apparent change in overall success.

Though the Hall technique shows promise as an alternative treatment modality, the question remains whether the carious lesion restored will be successfully sealed and arrested until the tooth naturally exfoliates. A 2013 systematic review showed incomplete caries removal can be considered advantageous and many of the studies reviewed showed sealing caries results in clinical and radiographic signs of inactivation of the carious lesion with tertiary dentin formation. [14] The use of glass ionomer cement

placed directly over carious dentin during indirect pulp therapy in primary teeth has been shown to be 93% successful after four years of follow-up.[15] Another study found the use of resin modified glass ionomer for indirect pulp therapy in primary molars to have a survival rate of 96% over three years.[16] One study following permanent teeth with remaining deep dentinal caries and a sealed restoration showed no lesion progression after 10 years.[17] Similar success of sealed caries in primary teeth would allow for these teeth to be successfully restored until exfoliation. Though it is impossible to evaluate the success of the seal provided by a SSC in vivo, studies on extracted primary molars have shown that SSC luted with resin modified glass ionomer cement have displayed little microleakage,¹⁶ and there is no significant difference in microleakage between intact and extensively carious primary molars restored with SSC.[18]

This study had several limitations. First, this study is retrospective, and the group of traditional SSC is not an ideal control since the majority of these crowns were provided during an earlier time period than the Hall technique group and patients were not randomly selected to receive either treatment modality. Secondly, the study's focus was on the clinical success of the crown as it related to loss or pulpal or caries related problems, and did not specifically measure periodontal health or changes in occlusion. However, a previous study specifically focusing on the change of occlusion observed in SSC placed using the Hall technique revealed overbite spontaneous equilibration after approximately 30 days.[19] Lastly, a statistically significant comparison was not achieved due to the infrequent incidence of failure relative to the sample size resulting in low statistical power. A well designed randomly controlled prospective trial between traditional preparation and Hall technique SSC would allow for a definitive comparison between the two modalities.

Conclusions:

This study showed that restoration survival is high for SSC provided by both a traditional preparation and the Hall technique by a pediatric dentist in a private practice setting. Even though follow-up duration was different for both groups, a majority of failures for both techniques were experienced in the first 2 years.

A large prospective randomized controlled clinical trial will be needed to adequately compare these two modalities to determine if there is a significant difference in restoration success.

Table 1: Protocol for providing SSC by the traditional preparation vs. Hall technique

	Traditional Preparation[20]	Hall Technique [8]
Use of nitrous oxide	Yes	Yes
Use of local anesthetic	Yes	None
Tooth preparation	2mm proximal slice, 1.5-2mm occlusal reduction, recontouring of bulbous anatomy	None, optional 1 mm proximal slice to allow seating in tight contacts
Caries removal	Complete	None, food and debris removed with air/water syringe
Crown Cementation	Resin modified glass ionomer*	Resin modified glass ionomer*

*During the course of the observation period, two materials were used for crown cementation by the practitioner regardless of technique: Fuji II LC, and Fuji CEM, GC America, Alsip, Illinois.

Table 2: Definitions of the Grading System for Clinical Success [7]

Restoration Success	Criteria
Crown Present	Date of last examination recorded without tooth exfoliation, the crown being present, and no further treatment required.
Tooth Exfoliation	Tooth exfoliation with no further intervention.
Restoration Failure	Criteria
Crown lost, tooth present	SSC became uncemented.
Further Treatment Required	Tooth required further treatment besides re-cementation of crown, including radiographic evidence of pulpal pathology or secondary caries evident.

Table 3: Outcomes of SSC Using the Hall technique and traditional preparation

TRADITIONAL PREPARATION			HALL TECHNIQUE		
Ascribed success	n	%	Ascribed success	n	%
Crown present	71	61	Crown present	64	96
Tooth shed	39	33	Tooth shed	1	1
Ascribed failure			Ascribed failure		
Crown lost, tooth present	2	2	Crown lost, tooth present	0	0
Tooth extracted	5	4	Tooth extracted	2	3

Table 4: Distribution of tooth number receiving SSC by treatment modality

Group	Tooth Receiving SSC Frequency (percentage)								
	A	B	I	J	K	L	S	T	Total
Hall	5 (7.46)	6 (8.96)	13 (19.40)	4 (5.97)	10 (14.93)	12 (17.91)	14 (20.90)	3 (4.48)	67
Traditional	7 (5.98)	12 (10.26)	16 (13.68)	9 (7.69)	10 (8.55)	29 (24.79)	28 (23.93)	6 (5.13)	117
Total	12	18	29	13	20	40	43	9	184

Figure 1: Hall technique pre-treatment and post-treatment: pre-treatment radiograph showing large occlusal caries and distal incipient lesion (a), pre-treatment photo (b), after providing distal proximal slice (c), seating of crown (d), pre treatment intercuspation (e), post-treatment intercuspation (f)

(Please see attached image file for Figure 1)

Figure 2: Patient age at time of treatment.

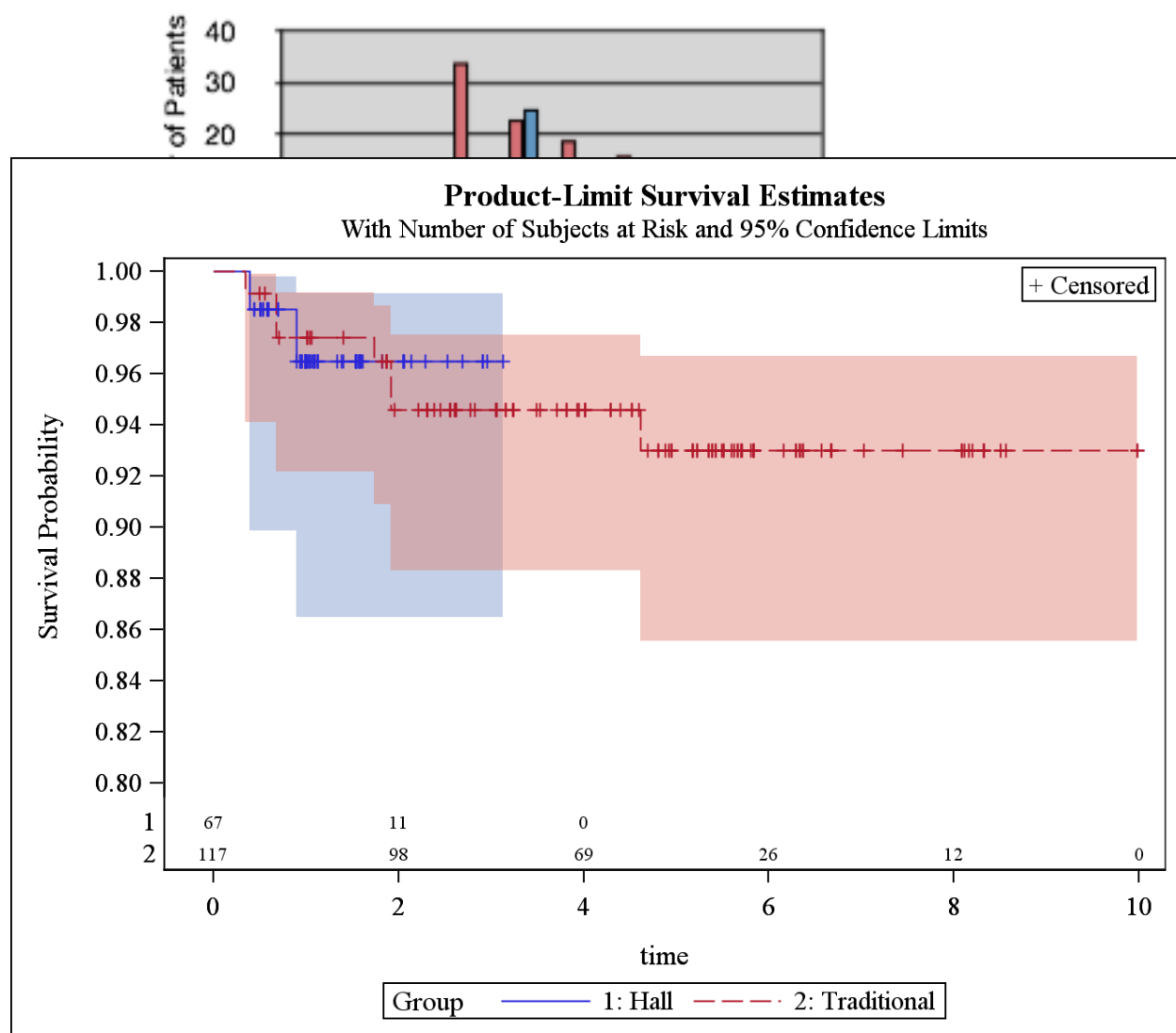


Figure 3: Kaplan-Meier survival curves along with 95% confidence intervals.

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