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A Comparison between Hall's Technique and the Conventional Method of Managing Proximal Caries in Primary Teeth

Research Article

Ahmad Kezawie[1], Mohamad Bashier Almonaqel[2], Imad Katbeh[3*], Tamara Kosyreva[4], Mahmoud Alawwad[5], Alexander Khasan[6], Mustafa Al-okbi[7]

[1] PhD student, Faculty of Dentistry, Department of Pediatric Dentistry, Damascus University, Syria.
[2] Professor, Faculty of Dentistry, Department of Pediatric Dentistry, Damascus University, Syria.
[3] Assistant Professor, Department of pediatric dentistry and orthodontics, Peoples' Friendship University of Russia (RUDN University), 117198 Miklukho-Maklaya Street 6, Moscow, Russia.
[4] Professor, The Head of the Department of Paediatric Dentistry and Orthodontics RUDN University (People's Friendship University of Russia). Russia, Moscow, 117198,), Miklukho-Maklaya Street.
[5] PhD student, Faculty of Dentistry, Department of Pediatric Dentistry, Damascus University, Damascus, Syria.
[6] Department of Prosthetic Dentistry Peoples' Friendship University of Russia (RUDN University), Miklukho-Maklaya Street 10/2, Moscow, Russia.
[7] Department of Pediatric Dentistry and Orthodontics RUDN University (Peoples' Friendship University of Russia). Russia, Moscow, 117198), Miklukho-Maklaya Street.

Abstract

The Hall Technique is a simple method of managing proximal caries in primary molars in which the carious lesion is sealed off by applying a stainless-steel crown to the primary molars without local anesthesia, removal of caries or tooth preparation.
This study is aimed at evaluating the success of proximal dentinalcaries management in non-symptomatic lower primary molars using the Hall's technique against the conventional method.Furthermore, to assess the vertical occlusal dimension immediately after crown fixation and the time required for an occlusal equilibrium to be achieved.
Materials and Methods: The study consisted of 120 primary lower molars (60 first molars and 60 second molars) with non-symptomatic proximal caries in 120 children of both sexes 6-7 years old. These molars,after being randomly distributed, were treated either by applying a stainless steel crown with Hall's technique or by conventional treatment with restoration with either amalgam or composite resin, and the cases were followed up within 6, 12, and 18 months to assess the success of the treatment clinically and radiographically. The vertical occlusal dimension was measured immediately after the application, and then evaluated after (2 weeks, 3 weeks, 1 month, 2 months).
Results: After 18 months of follow-up, the Hall technique's success rate was 100% clinically and radiologically, while the failure rate in the conventional treatment group was (13%), and most of the failures were on the first primary molar and in amalgam restorations.Balanced occlusion was restored in most cases (87%) within a month after intervention.
Conclusions: After 18 months of follow-up, we could say that Hall's technique is an effective method in the management of proximal dentinalcaries and has superior success rates over the conventional approach.

Keywords: Hall's Technique; Proximal Caries; Deciduous Molars.

Introduction

Despite the great development in preventive dental materials and methods, dentists still spend much of their time on routine restoration procedures of carious teeth [1].

Both pain and discomfort directly affect the child's behavior during treatment. in pediatric dentistry, treatment is ideal when the lesion is managed in an effective manner without causing any stress, anxiety, or discomfort to the child. The choice of treatment method, materials used for this purpose or the technique of restoration in primaryteeth depends mainly on assessing the carious lesion and the extent of its development and pulp status [2].

***Corresponding Author**:
Imad Katbeh,
Assistant Professor, Department of pediatric dentistry and orthodontics, Peoples' Friendship University of Russia (RUDN University), 117198 Miklukho-Maklaya Street 6, Moscow, Russia.
Tel: +79168268962
E-mail: katbeh@bk.ru

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Any treatment technique used to manage primary teeth caries should aim to achieve: 1) restoration of dental structures damaged by a carious lesion, 2) maintaining the integrity of both the remaining hard dental structures and the integrity of the dental pulp to prevent the development of any subsequent pulpal damage, 3) maintaining tooth function 4) providing a good aesthetic appearance when possible, 5) facilitating oral health care, 6) maintaining the integrity of the dental arch and providing the best conditions for the development of the permanent teeth [3].

Currently, there are two therapeutic approaches in the management of caries in primaryteeth, the conventional operative approach, and the biological conservative approach. For a long period of time, theoperative approach has been taught - and still is - in the management of dental caries, which states that the entire necrotic dentin should be completely removed and then an appropriate restorative material should be applied [4]. It must be recognized that the conventional operative treatment of carious teeth, including local anesthesia and the use of rotary instruments and various materials, is an expected source of discomfort for the child, which makes him refuse to come for treatment despite his pain [5]. In addition, the complete removal of carious dentin, which includes the removal of both infected and affected dentin until reaching a hard layer of dentin free of discoloration, means sacrificing the remineralized dental tissue thus reducing the thickness of the remaining layer of dentin covering the pulpthat is important to the integrity of the dental pulp [6].

In deep dentinal caries on primarymolars with no clinical or radiological symptoms, complete removal of caries may lead to pulpal exposure and require post-exposure treatment (pulpotomy, pulpectomy), which means removal of more dental tissues with varying success rates and greater cost [7].

Unlike permanent teeth, the deciduous teeth are temporary, and their fate is to be replaced with permanent teeth. This is an advantage that allows us to apply a set of techniques aimed to slowing or stopping the development of a carious lesion for a sufficient period of time until the time of its natural replacement without exposing the child to conventional treatment with the tooth remaining asymptomatic, showing no signs of abscess [8].

Schwendicke, F., et al., stated that controlling the disease in cavitated carious lesions should be attempted using methods which are aimed at biofilm removal or control first.Thus,less invasive carious lesion management, delaying entry to, and slowing down, the restorative cycle by preserving tooth tissue and retaining teeth long-term are recommended [9].

The biological conservative approach to the management of primarydental caries includes a wide range of techniques and possible methods, like partial removal of caries and restoration in one session or partial removal of caries with retreatment of the lesion (stepwise removal), stopping the advanced carious lesion by fluorideapplication in its various forms, filling and sealing the necrotic lesion with a restorative material without removing the necrotic tissue or non-operative cavity treatment, as in this method no necrotic tissue removal is performed, but only the opening of the necrotic lesion to facilitate cleaning and brushing by the parent or child, which may allow preventing the development of the lesion [10].

Under this biological conservative approach, a new technique called Hall's technique is included in which the caries lesion is sealed using a stainless steel crown without using local anesthesia, removal of caries or any preparation of the tooth [11].

Hall's technique aims to influence the tissue environment by sealing the carious lesion off and isolating it from the necessary nutrients it was receiving from the oral environment. There is good evidence that the effective sealing of a carious lesion has a direct effect on the activity and reproduction of the plaque germs, transforming the plaque into a less necrotic environment, allowing the development of this lesion to stop [12].

In Hall's technique, a stainless steel crown is applied without any prior reduction of the occlusal surface of the primarymolar, and this necessarily lead to the creation of premature contact point on the occlusal surface of the molar, and the subsequent occlusal interference [13].

This study aimed to evaluate the clinical and radiological success of proximal dentinalcaries management in non-symptomatic lower primary molars using Hall's technique, compared to those treated by the conventional method and restored with dental amalgam or composite resin. Furthermore, to evaluate the occlusion and the time required to achieve an occlusal equilibrium after applying Hall's technique.

Materials and Methods

The study sample included 120 children between 6-7 years of age referred to the Department of Pediatric Dentistry, Faculty of Dentistry, Damascus University, Syria. Each child had just one tooth treated, either with Hall's technique or the conventional method, the research sample was randomly divided into two equal groupsaccording to the treatment method followed.

The study was approved by the Ethics Committee of Damascus University. The informed consent was obtained from each child's parents after a thorough explanation about treatment requirements.

Inclusion criteria

1.Healthy, cooperative children 6-7 years old.
2.Having aprimary lower molar with a proximal carious lesion in accordance with No. 4 Standard of the International Caries Detection and Assessment System (ICDAS), without marginal ridge enamel breakdown.
3. Radiologically: caries is limited within the middle third of dentin when imaging in parallel (a clear sign of intact dentin separates the edge of the carious lesion from the pulp chamber) [14].
4. Teeth are asymptomatic, i.e. there are no clinical and/or radiological symptoms or signs of pulpal necrosis (pulpitis - absence of radiological signs: bifurcation lesions - apical lesion - periapical abscess).
5. The antagonist molars to the studied molar are intact, appropriately treated, or not significantly damaged.
6. The presence of primary canine on both sides, with a class one contact relationship.

Exclusion Criteria for Hall's Treatment technique

1- Children with health problems that are inconsistent with the use of Hall's technique (heart disease, immunodeficiency), as it is preferable in such cases to manage caries by the conventional method after removing the entire carious lesion [12].
2- Children who are uncooperative and who exhibit behavior that cannot be treated with basic behavior management methods, which have a higher risk of swallowing or inhaling the crown during work [15].
3- Temporomandibular joint disorder in a child (clicking, locking, pain, or limited movement or deviation in the jaw when opening or closing) so that the occlusal disturbance expected after the application of Hall's technique does not cause an exacerbation of the current problem.
4-Children with bruxism.
5- Children with orthodontic problems.
6- The parents' or the child'srejection of this procedure due to dissatisfaction with the aesthetic appearance of the stainless-steel crown.

Hall's group work method

Before starting the application of the Hall's crown technique, an assessment of the child's occlusion was carried out in the normal static position and made sure that there were sufficient dental units on the dental arches to secure stable and repeatable occlusion. The occlusion was evaluated on the primary teeth adjacent to the teeth to be crowned and on the teeth at the other side by using biting paper with a thickness of 40 microns. The child's static occlusal condition was documented before application, immediately after application, and during follow-up periods, with a set of front and side pictures.

Hall's technique was applied according to the protocol published by Innes et al. [15]. Sixty crowns were cemented (Kids Crown from the South Korean Shinhung Company) using GC FujiI (TOKYO, JAPAN) adhesive according to the manufacturer's instructions.

Post-operative instructions

No eating or drinking for at least two hours after application, gingival discoloration around the edges of the crown is a normal occurrence and will disappear within an hour at most.

The conventional work method

60 class 2 conservative restorations were completed (30 restorations with dental amalgam and 30 restorations with composite). First, local anesthesia was performed, and then the isolation was done using a rubber dam, then the preparation was done using a hard diamond bur mounted on a turbine handpiece with a fast rotation with continuous spray of water in accordance with the well-known Black principles. Any remaining caries was removed by means of a round bur carried on a slow-speed handpiece or with a sharp pear-shaped bur. After the preparation was completed, the tooth was rinsed with a water spray and then dried with a gentle airflow, and a suitable matrix was applied to Tofflemire type retainer and then a wooden wedge was inserted between the tooth and adjacent tooth and below the gingival base of the preparation.

Upon restoration with amalgam, the amalgam capsule (BMS) was mixed according to the manufacturer's instructions and then transferred to the prepared cavity in batches starting with the adjacent cavity until the cavity was filled and slightly over its boundaries and after about two minutes the matrixwas removed with the wedge and then carving and polishing were done. After that we removed the rubber barrier and examined the child's occlusion witha biting paper and made appropriate modifications. Finishing and polishing were performed for all completed amalgam fillings at a later date (after one or two days).

When restoring with composite resin: the acid etching was performed first with the use of 37% phosphoric acid (Tetric N-Etch), then washing and drying, then applying the bonding system (Tetric® N-Bond), then the light curing was performed for the bonding system for a period of (20 seconds) then applying the composite resin material (Tetric N-Ceram) to the prepared cavity with the metal composite application tool, the material was appliedin the form of layers so that the thickness of each layer does not exceed 2 mm, where light curing is performed for each added layer for a period of 20 seconds according to the manufacturer's instructions. The matrixwas then removed, and the finishing was done using turbine diamond composite finishing burs with continuous water spray.

Measurement of the vertical occlusal dimension

The initial (before application of the crown) color-defined contact lines on both the upper and lower canines were used as reference points to assess the occlusion.

The vertical distance formed between the canines as a result of bite opening after application of the crown was filled with colored composite resin (blue), the composite was adapted in a way that vertically fills the void area formed between the two color-defined contact lines between the upper and lowercanines. After the crown was applied, the child was asked to bite tightly and firmly and to not open the mouth or make any movements until we have recorded the height of occlusion.

The composite resin was cured for 40 seconds, after which a piece of hardened resin was used to measure its height using digital electronic calipers (Mitutoyo, Tokyo, Japan) with a margin of error in the accuracy of the measurement not exceeding 0.01 millimeters, so that this measured height is considered to be the increased height of the occlusion.

Only children treated with Hall's technique were put on a sequential follow-up program to assess and determine the time required to return to a state of a balanced occlusion, they were evaluated two weeks after the application, and if maximum intercuspation was not achieved, the child was re-examined at the next follow-up appointment after another week, i.e. after 3 weeks from the application, then a month after the application, and two months after the application.

The return of the contact between the upper and lower canines on both sides together with maximum intercuspation on the molars examined before application was considered a criterion for the return to the balanced occlusionwhich was confirmed by using biting paper measuring 40 microns on both sides together [16].

Assessment of clinical and radiological success and failure

All children included in the study were placed on a sequential follow-up program (after 6 months, after 12 months, after 18 months) to assess the clinical and radiological success and failure of each of the two research groups.

The clinical evaluation of the treatments was carried out in order to assess success and failure by three dentists specialized in pediatric dentistry to give the degree of clinical success or failure after a consensus of the two of the evaluators on this score according to the following:

Clinical failure criteria for Hall's technique were 1) The presence of any clinical symptoms or signs indicating the occurrence of pulpitis or abscess 2) Detachment of the crown or perforation in the stainless-steel crown 3) New caries around the edges of the crown.

Clinical success criteria for Hall's technique were 1) The crown is well placed and does not require any correction 2) There are no symptoms or clinical signs of pulp injury.

Clinical failure criteria for the conventional method 1) The presence of any clinical symptoms or signs indicating the occurrence of an abscess 2) The loss of the entire restoration or a large part of it, which indicates filling replacement 3) The presence of recurrent caries that needs to be removed and restored again 4) The presence of a visible crack on the edges with exposed dentine4) Deep pigmentation, visible along the edges, extending towards the pulp and encompassing most of the edges of the restoration. Clinical success criteria for the conventional method 1) The restoration is well placed and does not require any correction 2) The absence of any clinical signs or symptoms indicating pulp injury. After the completion of the clinical evaluation of the performed treatments (conventional and Hall's technique), the radiographic evaluation was performed to determine the cases of success and failure by performing a digital intraoral periapical (IOPA) radiograph according to the following:

Radiological failure criteria for Hall's technique were 1) The presence of radio-translucency in the bifurcation region 2) The presence of radio-translucency in the apical region of the molar roots 3) Periodontal ligament space widening 4) Pathological rootresorption (internal or external) 5) The occurrence of an ectopic eruption of the first permanent molar adjacent to the second primary molar to which we applied the crown by Hall's technique.

Radiological success criteria for Hall's technique was the absence of allof the mentioned pathological radiological signs.

Radiological failure criteria for the conventional method 1) The presence of radio-translucency in the bifurcation region 2) The presence of radio-translucency in the apical region of the molar roots 3) Periodontal ligament space widening 4) Pathological root resorption (internal or external) 5) The presence of radiographic evidence of recurrent caries.

Radiological success criteria for the conventional method was the absence of all of the mentioned pathological radiological signs.

Note: Treatment (conventional or Hall) was considered successful in the event that both clinical and radiological success were achieved together, and it was considered to have failed in the event of any clinical or radiological failure, or both.

Statistical Analysis

The statistical calculations of the research were performed using SPSS version 20.0(SPSS Inc., Chicago, IL, USA), where the percentages of successes and failures were calculated for the study groups, and the chi-square test was used to study the significance of the differences between success and failure frequencies between them. Student's T-test was used for independent samples to study the effect of the type of theprimary molar type (first or second) on the amount of vertical occlusal dimension.The results were consideredsignificant if $p \leq 0.05$.

Results

Table (1) shows the description of the sample. Table (2) shows analytical statistical studyof thevertical occlusal dimension changes according to the type of the lower primary molar studied. Table (3) shows the results of monitoring the time required for the return of balanced occlusion in the research sample according to the type of the lower primary molar examined. Table (4) shows the clinical and radiological treatment outcomes in the research sample according to the treatment approach used and the time period studied. Table (5) shows the results of the chi-square test to study the significance of the differences in the frequency of treat-

Table 1. Shows the distribution of the research sample according to the type of the lower primary molar (lower primary first molar / lower primary second molar) and the method of restoration used.

The method of restoration used	The number of cases			percentage		
	First primary lower molar	second primary lower molar	Total	First primary lower molar	A second primary lower molar	Total
Hall technique	30	30	60	50	50	100
Use of Tetric N-Ceram Composite Resin	15	15	30	50	50	100
Use of BMS amalgam	15	15	30	50	50	100
The complete research sample	60	60	120	50	50	100

Table 2. Shows the arithmetic mean, the standard deviation, the standard error, the lower and upper limit values of vertical occlusal dimension in the canine region (in mm) immediately after the crown is fitted in the research sample according to the type of the lower primary molar studied.The differences between groups were statistically significant (p <0.05).

The type of the lower primary molar considered	The number of primary molars	Mean	standard deviation	Standard error	Lower limit	upper limit
First primary lower molar	30	1.01	0.5	0.09	0.23	1.82
Second primary lower molar	30	1.34	0.56	0.1	0.42	2.41
The complete research sample	60	1.17	0.56	0.07	0.23	2.41

Table 3. Shows the results of monitoring the time required for the return to a balanced occlusion in the research sample according to the type of the lower primary molar examined.

type of the lower primary molar considered	The number of primary molars / (percentage)				
	two weeks	three weeks	one month	two months	total
First primary lower molar	9 / (30.0%)	6 / (20.0%)	10 / (33.3%)	5 / (16.7%)	30 / (100%)
Second primary lower molar	7 / (23.3%)	9 / (30.0%)	11 / (36.7%)	3 / (10.0%)	30 / (100%)
The complete research sample	16 / (26.7%)	15 / (25.0%)	21 / (35.0%)	8 / (13.3%)	60 / (100%)

Table 4. Shows the clinical and radiological treatment outcomes in the research sample according to the treatment approach used and the time period studied.

The period studied	The type of treatment approach taken	The number of cases / (percentage)		
		Clinical and / or radiological failure	Clinical and radiological success	total
After 6 months	Hall's technique	0 / (0%)	60 / (100%)	60 / (100%)
	conventional	0 / (0%)	60 / (100%)	60 / (100%)
After 12 months	Hall's technique	0 / (0%)	60 / (100%)	60 / (100%)
	conventional	2 / (3.3%)	58 / (96.7%)	60 / (100%)
After 18 months	Hall's technique	0 / (0%)	60 / (100%)	60 / (100%)
	conventional	8 / (13.3%)	52 / (86.7%)	60 / (100%)

Table 5. Shows the results of the chi-square test to study the significance of the differences in the frequency of treatment results clinically and radiographically between the group using Hall's technique and the group using the conventional method in the research sample, according to the time period studied.

The two variables studied = type of treatment approach x outcome of clinical and radiological treatment				
The period studied	**The number of cases**	**Chi-square value**	**Degrees of freedom**	**P-value**
After 6 months	120	-	-	-
After 12 months	120	2.034	1	0.154 (NS)
After 18 months	120	8.571	1	0.003*
*significant difference at p=0.05 (NS): Nonsignificant difference				

ment results clinically and radiographically between the group using Hall's technique and the group using the conventional method in the research sample, according to the time period studied.

The results of the Chi-square test showed that the level of significance 0.003 is much smaller than the value 0.05 after 18 months, that is, at the 95% confidence level, there are statistically significant differences in the frequencies of the treatment outcome, clinically and radiologically, between the group using Hall's technique and the group using the conventional method in the research sample. By studying the corresponding table of frequencies and percentages (Table 4), it was noted that the clinical and radiological success rate after 18 months in the Hall's technique group was greater than in the conventional method group in the research sample.

Table (6) shows clinical and radiological treatment results in the

Table 6. Shows clinical and radiological treatment results in the research sample according to the type of restoration material used and the time period studied.

The period studied	The method of restoration used	The number of cases / (percentage)		
		Clinical and/or radiological failure	Clinical and radiological success	total
After 6 months	Hall's technique	0/(0%)	60/(100%)	60/(100%)
	Use of Tetric N-Ceram Composite Resin	0/(0%)	30/(100%)	30/(100%)
	Use of BMS amalgam	0/(0%)	30/(100%)	30/(100%)
After 12 months	Hall's technique	0/(0%)	60/(100%)	60/(100%)
	Use of Tetric N-Ceram Composite Resin	0/(0%)	30/(100%)	30/(100%)
	Use of BMS amalgam	2/(6.7%)	28/(93.3%)	30/(100%)
After 18 months	Hall's technique	0/(0%)	60/(100%)	60/(100%)
	Use of Tetric N-Ceram Composite Resin	2/(6.7%)	28/(93.3%)	30/(100%)
	Use of BMS amalgam	6/(20.0%)	24/(80.0%)	30/(100%)

Table 7. Shows clinical and radiological treatment results in the research sample according to the type of restoration material used, the type of the lower primary molar and the time period studied.

The time period studied	Type of the lower primary molar	The method of restoration used	The number of cases / (percentage)		
			Clinical and / or radiological failure	Clinical and radiological success	total
After 6 months	First primary lower molar	Hall's technique	0 / (0%)	30 / (100%)	30 / (100%)
		Use of Tetric N-Ceram Composite Resin	0 / (0%)	15 / (100%)	15 / (100%)
		Use of BMS amalgam	0 / (0%)	15 / (100%)	15 / (100%)
	Second primary lower molar	Hall's technique	0 / (0%)	30 / (100%)	30 / (100%)
		Use of Tetric N-Ceram Composite Resin	0 / (0%)	15 / (100%)	15 / (100%)
		Use of BMS amalgam	0 / (0%)	15 / (100%)	15 / (100%)
After 12 months	First primary lower molar	Hall's technique	0 / (0%)	30 / (100%)	30 / (100%)
		Use of Tetric N-Ceram Composite Resin	0 / (0%)	15 / (100%)	15 / (100%)
		Use of BMS amalgam	2 / (13.3%)	13 / (86.7%)	15 / (100%)
	Second primary lower molar	Hall's technique	0 / (0%)	30 / (100%)	30 / (100%)
		Use of Tetric N-Ceram Composite Resin	0 / (0%)	15/ (100%)	15/ (100%)
		Use of BMS amalgam	0 / (0%)	15/ (100%)	15/ (100%)
After 18 months	First primary lower molar	Hall's technique	0 / (0%)	30 / (100%)	30 / (100%)
		Use of Tetric N-Ceram Composite Resin	1 / (6.7%)	14 / (93.3%)	15 / (100%)
		Use of BMS amalgam	4 / (26.7%)	11 / (73.3%)	15 / (100%)
	Second primary lower molar	Hall's technique	0 / (0%)	30 / (100%)	30 / (100%)
		Use of Tetric N-Ceram Composite Resin	1 / (6.7%)	14 / (93.3%)	15 / (100%)
		Use of BMS amalgam	2 / (13.3%)	13 / (86.7%)	15 / (100%)

research sample according to the type of restoration material used and the time period studied.

Table (7) shows clinical and radiological treatment results in the research sample according to the type of restoration material used, the type of the lower primary molar and the time period studied.

Discussion

It was found in this study that the average amount of increased height of occlusion in the region of the primary canines at the point of application among the cases in which the stainless steel crown was applied with Hall's technique on the lower primary first molar was about 1 mm, while it reached 1.34 mm when applying the technique to the lower primary second molar.

The amount of increased occlusal height in the area of the canines when applying the Hall's technique to the primary second molar was greater than when applying the technique to the primary first molar and this was expected as it is natural that the amount of change in the vertical occlusal dimension increases whenever the tooth on which the occlusal interference occurs is more posterior, or when the measurement is taken more anteriorly [17].

Van der Zee, V. and W. Van Amerongen [18] found a decrease in the amount of canine coverage after applying the Hall's stainless-steel crown to 48 children. The average vertical distance measured between the cusp tip of the upper and lower canines before application was 2.45 mm, decreasing to 0.54 mm immediately after application, meaning that the amount of increase in The vertical dimension in general was 1.91 mm. It must be noted that in their study there was no indication of the type of a molar (first or second) and in many cases the child had received treatment for more than one molar with Hall's technique in the same session (from one molar up to four molars), and in some cases they hadthe crown applied to two opposite molars in the same session as well, which caused a greater increase in the vertical dimension, causing a slower return to a balanced occlusion.

According to the UK National Clinical Guidelines in Paediatric Dentistry for the Application of a Stainless Steel Crown [19], the occurrence of premature contact on the crown and the resulting increase invertical height of about 1 mm is something that is usually well tolerated in children, who appear to have a great capacity for dental-alveolar compensation to adapt to such emergency changes without any problems and such changes often resolve within a few weeks.

The results of the current study showed that after two weeks of applying the Hall's crown technique to the lower primary molars, 27% of cases (30% for the first molar and 23% for the second molar) had a bilateral balanced occlusion, while about 25% of the cases (20% For the first molar and 30% for the second molar) needed up to three weeks to obtain a bilateral balanced occlusion, and 35% of cases required about a month to obtain abilateral balanced occlusion. We noted that after a month of application, 87% of cases (84% for the first molar and 90% for the molar the second) have returned to the position of a balanced occlusion bilaterally and the remaining cases of 13% (17% for the first molar and 10% for the second molar) took more than a month, achieving a balanced occlusion upon examination after two months, which is consistent with most of the previous studies that also found that the Occlusal Vertical Dimension returned to a balanced state about a month after application [18, 20, 21].

Also, it should be noted thatthe success rate in managing proximal caries that extend to the middle third of the dentin on both the first and second primary lower molars with the Hall's technique reached 100% during 18 months of follow-up, while a success rate of (87%) was reached during 18 months of follow-up in the conventional treatment group. It might be due to the superiority of the stainless-steel crown over the rest of the other restorations in primary molars in terms of effectiveness and durability [22]. On the other hand, it goes back to the fact that the development of a necrotic lesion is related to the biofilm of the bacterial plaque and that sealing the necrotic lesion (Hall's technique) and isolating it from the necessary nutrients that it was receiving from the oral environment has a direct effect on reducing the activity and reproduction of the plaque bacteria, allowing the development of this lesion to be slowed or stopped [12].

Similarly to what was found in this study, it was found in many previous studies that the Hall's technique was superior to conventional treatment (using different restorative materials) in the management of primary asymptomatic molar caries as in the study of Innes et al. [23] in Scotland, where they found a primary failure in the group of conventional treatments is 15% (represented by the occurrence of an abscess,irreversible pulpitis or loss of restoration) and a secondary failure (represented by the occurrence of any of any types of failure not requiring pulpotomy or pulpectomy) by 46% after an average monitoring period of 23 months while the percentage of a primary failure of the Hall-treated molars was 2% and secondary failure rate 5% during the same follow-up period.

The higher rate of failure in their conventional treatment group compared to what was found in the present study may be attributed to several reasons, including the use of glass ionomer cement in most class II restorations, which is one of the materials currently known for low success rates in such restorations. Also one of the reasons might be the long follow-up period (about two years), as it is logical to have high failure rates of primary molars restorations over long period of time [24], and also the fact that most restorations were performed without the use of local anesthesia or the application of a rubber dam, which was applied routinely to all children in the present research.

The results of this study are consistent with the results of BaniHani et al. [25] in terms of the high rate of success in molars treated according to the biological approach (Hall's technique or indirect pulp capping), as the success rate after an average follow-up of 13 months reached 95.5%, But differed with their results regarding that they did not find an advantage of the biological approach over the conventional method (complete removal of caries), in which the success rate was 95.3%. The reason for the difference may be due to their use of composite resin in most restorations of the conventional method without using amalgam except in a small percentage of cases less than 1%, while we used amalgam for half of the research sample treated by the conventional method, as most of the failures occurred in these amalgam restorations. On the other hand, conservative restorations were applied in their study on the second primary molars with a rate of

double that of the first primarymolars, while this research included the two molars in equal proportions and most of the failures occurred on the first primary molars.

The results of this study are in agreement with the results of the study of Santamaria et al. [26] who found that there was no occurrence of any primary failure case (dental abscess/irreversible pulpitis) for primary molar proximal cariesin Hall'stechnique during one year of follow-up while the failure rate was in the conventional treatment group 29% (Complete removal of caries and composite restoration). Most of the secondary failures and all the primary failures occurred on the first primary molar.

The results of this study also showed that conservative restorations applied to the first primarylower molar have failure rates that reached (17%) after 18 months of follow-up, which is greater than those of the restorations applied to the second molar (10%) for caries of the same type (proximal caries) and the same size (the extension is confined to the middle third of the dentin). It is speculated that the small size of the first primarymolar compared to the second primarymolar is one of the reasons that putproximal restorations at greater risk of subsequent failure [27].

Conclusions

The application of a stainless steel crown with Hall's technique on the lower primary molars was an effective method in management of asymptomatic proximal caries, as the clinical and radiological success rate of the molars treated with this technique reached 100% during 18 months of follow-up period and it is more effective than the conventional operativetreatment, especially when restoring with dental amalgam.

- The failure rate of conventional restorations on the lower primary first molar is greater than that of the lower primary second molar within 18 months of follow-up.
- The application of a stainless-steel crown with Hall'stechnique on the lower primary molars caused anincreased occlusal height in the primary canines' area with an average increase of 1.17 mm. This occlusal disorder is temporary, and the occlusion returns to a state of balance in most cases within a month of application.

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