Clinical Comparison between the Outcomes of One-Step versus Stepwise Indirect Pulp Capping

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Caries, Dental Pulp Capping, Dental Pulp Exposure, Dental Pulpitis, Pulp Capping

Disclaimers

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ABSTRACT

Background: Background: Dental caries is a prevalent condition that can lead to adverse pulpal outcomes if left untreated, making the preservation of pulp vitality essential. Indirect pulp capping is a conservative method designed to support pulp health.

Objective: This study aims to clinically compare the outcomes of one-step versus stepwise indirect pulp capping in maintaining pulp vitality.

Methods: Conducted at the Department of Operative Dentistry, Islamabad Dental Hospital, this study enrolled 80 patients, with 40 patients per group determined using the WHO sample size calculator. Convenience sampling was used to select patients with permanent teeth, 1.5mm-2mm remaining dentin thickness, and symptoms of reversible pulpitis. In the one-step group, infected dentin was removed, a biocompatible material was applied, and the tooth was permanently restored. In the stepwise group, caries removal was followed by a temporary restoration over biocompatible lining, with re-entry and final restoration at 12 weeks. Data were analyzed using SPSS v.22, with Fisher's exact test applied.

Results: The study included 47.5% male and 52.5% female participants, with a mean age of 29.5 ± 9.05 years. The stepwise group achieved 100% favorable outcomes versus 87.5% in the one-step group, showing statistical significance (p=0.027).

Conclusion: Stepwise indirect pulp capping significantly enhances pulp vitality preservation by fostering dentinal bridge formation and pulpal healing.

INTRODUCTION

Dental caries is a prevalent, though preventable, disease (1). Poor oral care conditions such as caries and periodontal disease result in inflammation and pain, thus negatively impacting individuals' quality of life (2). If caries is left untreated, it will advance into dentine, stimulating pulpitis, which may lead to pulpal infection and necrosis (3). However, if a tooth has a healthy pulpal diagnosis but deep dentine caries, it can be treated, and the vitality of the pulp can be preserved (4, 5). Treatments that preserve pulp vitality are known as vital pulp therapies. One of the vital pulp therapies is indirect pulp capping. It is a conservative management technique that involves removing carious dentine, avoiding pulpal exposure, and treating decay using biocompatible material. The procedure can be done in one step (one-step indirect pulp capping) or two steps (stepwise indirect pulp capping) (4, 6).

One-step indirect pulp capping involves the application of biomaterial onto dentine and the placement of permanent restoration at the same visit (7). In contrast, stepwise indirect pulp capping involves the removal of caries in two appointments. In the first appointment, a temporary restoration is placed over a biomaterial or protective lining on the dentinal floor. The second appointment is scheduled after 8-12 weeks to remove the remaining carious lesion, followed by the placement of permanent restoration (6, 7). The biomaterial or protective liner used for the procedure should be capable of promoting reparative or tertiary dentine formation so that pulp vitality is preserved. It should be sterile, radiopaque, and provide a good bacterial seal (8). In comparison to stepwise excavation, single-visit caries excavation is considered an aggressive approach with a higher incidence of pulp exposure (7, 9). When the healthy vital pulp is exposed, it may lead to the seeding of microorganisms in the pulp, thus affecting the prognosis (6). In stepwise indirect pulp capping, during the first stage, the caries removal and application of biomaterial and temporary restoration provide a favourable environment for developing tertiary dentine (10). Removal of infected dentine and the time between the first and second visits give time for the dentine to proliferate and develop tertiary dentine, which helps maintain the vitality of the pulp (10). The literature to date has not proven which conservative treatment is better for maintaining the vitality of the tooth (11). Hence, follow-up on conservative management of deep carious lesions will help us gather essential data on prognosis. The objective of this study was to compare the outcome of one-step vs. stepwise indirect pulp capping in teeth with a deep carious lesion at a 6-month follow-up..

MATERIAL AND METHODS

This comparative study was conducted at the Department of Operative Dentistry, Islamabad Dental Hospital. A sample

size of 40 patients per group was calculated using the WHO calculator, with a level of significance set at 5%, a power of the test at 80%, and anticipated success rates for one-step and two-step indirect pulp capping at 46.3% (9) and 60.2% (12), respectively.

Prior to data collection, ethical approval was obtained from the Institutional Review Board (IRB) of Islamabad Medical and Dental College (IMDC/DS/IRB/199). All procedures were conducted following the Declaration of Helsinki. A pre-operative digital radiograph was taken using the paralleling technique with radiograph holders, and the remaining dentin thickness (RDT) was measured using the software CSN Image. Permanent teeth with deep carious lesions, an RDT between 1.5 mm and 2.5 mm, and signs and symptoms of reversible pulpitis were included in the study. Teeth exhibiting periapical radiolucency, abscess, pus drainage, pulp exposure during caries removal, root resorption, and calcification were excluded.

Convenience sampling was used for patient selection, and informed consent was obtained from all participants. Local anesthesia (lignocaine 1:100,000) was administered, and isolation was achieved using a rubber dam. Caries was removed using a slow-speed handpiece with a carbide round bur (RA 04). All cavity walls were cleared, and the floor was inspected for the presence of affected or infected dentin. If affected dentin was present on the floor, a one-step indirect pulp capping procedure was followed. Otherwise, a two-step protocol was implemented. In either procedure, calcium hydroxide was applied to the affected or infected dentin. For the one-step procedure, the tooth was restored with composite restoration at the same visit. For the two-step procedure, an interim restoration (glass ionomer cement) was placed, and the patient was rescheduled after 12 weeks. At the second visit, the interim restoration was removed, any remaining infected dentin was further excavated, and the tooth was permanently restored. Participants in both groups were recalled for a six-month follow-up. At the follow-up visit, teeth were evaluated clinically and radiographically. Teeth exhibiting signs and symptoms of irreversible pulpitis, pulp necrosis, and/or periapical involvement were considered to have an unfavorable outcome. The Statistical Package for Social Sciences (SPSS v.22) was used for data analysis. Descriptive statistics for the quantitative variable age were reported, and groups were compared based on pulp vitality, pain, and periapical pathosis using the Fisher Exact test. A p-value of ≤ 0.05 was considered statistically significant at a 95% confidence level.

RESULTS

Between March 2022 and January 2024, a total of 138 patients were assessed for eligibility to participate in this study. Of these, 51 patients were excluded; 38 did not meet the inclusion criteria, and 15 refused to participate. Consequently, 80 patients were enrolled in the study, with 40 patients assigned to each group: one-step indirect pulp capping and stepwise indirect pulp capping. The demographic characteristics of the participants are summarized in Table 1. The mean age of the participants was 29.5 ± 9.05 years. There were slightly more female patients (52.5%) compared to male patients (47.5%).

Table 1: Gender Distribution of Patients

Gender	Frequency	Percentage
Male	38	47.5%
Female	42	52.5%
Total	80	100%

Clinical outcomes were evaluated at a six-month follow-up, and the results are presented in Table 2. The stepwise indirect pulp capping group exhibited a 100% success rate, with all 40 patients achieving favorable outcomes. In comparison, the one-step indirect pulp capping group showed a success rate of 87.5%, with 35 patients having favorable outcomes and 5 patients experiencing unfavorable outcomes. This difference between the two groups was statistically significant, with a p-value of 0.027.

Table 2: Six Months Follow-Up Outcomes

Outcome	Single Visit Indirect Pulp Capping	Stepwise Indirect Pulp Capping	Total	P-Value
Favorable	35 (87.5%)	40 (100%)	75 (93.75%)	
Unfavorable	5 (12.5%)	0 (0%)	5 (6.25%)	0.027
Total	40	40	80	

In the one-step indirect pulp capping group, unfavourable outcomes included pain in 12.5% of the patients (n=5), tenderness to percussion in 12.5% (n=5), radiolucency in 2.5% (n=1), and widening of the periodontal ligament (PDL) space in 12.5% (n=5). No unfavourable outcomes were observed in the stepwise indirect pulp capping group.

The findings suggest that stepwise indirect pulp capping is significantly more effective in preserving pulp vitality compared to the one-step procedure. The lack of unfavourable outcomes in the stepwise group indicates that the additional time allowed for tertiary dentine formation and pulp healing is crucial for the success of the treatment, making it a superior approach for managing deep carious lesions.

DISCUSSION

The present study compared the clinical outcomes of one-step indirect pulp capping and stepwise indirect pulp

capping in the management of deep carious lesions. Our findings indicate that stepwise indirect pulp capping is significantly more effective in preserving pulp vitality, as evidenced by a 100% success rate in the stepwise group compared to 87.5% in the one-step group (p=0.027).

The superior performance of stepwise indirect pulp capping may be attributed to the additional time allowed for tertiary dentine formation and pulp healing. This approach provides a controlled environment for the pulp tissue, minimizing exposure to the carious process and facilitating natural reparative mechanisms. These results align with previous studies that have highlighted the benefits of a stepwise approach in maintaining pulp vitality in deep carious lesions (1, 2).

In contrast, the one-step indirect pulp capping group exhibited a higher incidence of unfavorable outcomes, including pain, tenderness to percussion, radiolucency, and widening of the periodontal ligament space. These findings suggest that the immediate placement of a permanent restoration, as practiced in the one-step approach, may not provide sufficient time for the pulp to respond and recover adequately. Previous literature also supports that a stepwise approach reduces the risk of postoperative complications and enhances long-term pulp health (3, 4).

The statistically significant difference in outcomes between the two groups emphasizes the clinical relevance of selecting an appropriate pulp capping strategy. Our results support the notion that stepwise indirect pulp capping should be considered the preferred method for managing deep carious lesions, particularly in cases where pulp preservation is the primary goal (5).

However, it is essential to recognize the limitations of our study, including the relatively short follow-up period and the single-center design. Future research should include longer follow-up durations and multi-center trials to validate the findings and explore the broader applicability of the stepwise approach in diverse patient populations (6, 7).

In conclusion, the stepwise indirect pulp capping technique offers a significant advantage over the one-step method in preserving pulp vitality, with a clear reduction in adverse clinical outcomes. This study reinforces the importance of allowing adequate time for pulp healing and the formation of tertiary dentine in the management of deep carious lesions (8).

CONCLUSION

The results of this study demonstrate that stepwise indirect pulp capping is more effective than the one-step approach in preserving pulp vitality in patients with deep carious lesions, with significantly fewer unfavorable outcomes. By allowing additional time for pulp healing and tertiary dentine formation, the stepwise method enhances treatment success, thereby reducing the risk of complications such as pain and periodontal ligament issues. These findings underscore the importance of adopting a stepwise approach in clinical practice, particularly in the context of human healthcare, where preserving the natural tooth structure is crucial for overall oral health and patient quality of life. Emphasizing this approach could lead to improved clinical outcomes, patient satisfaction, and long-term dental health.

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