



## Evaluation of Caries Removal Efficiency of the Operator Under Unaided Vision, Loupes and Microscope – An In-Vivo Study

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### KEYWORDS

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Magnification;

Dental Loupes;

Minimally

Invasive Surgical  
Procedures;

Treatment  
Outcome

### ABSTRACT:

**Introduction:** Achieving complete caries removal while preserving sound tooth structure is essential in minimally invasive dentistry. Enhanced visualization through magnification may improve excavation accuracy compared with unaided vision.

**Methods:** Thirty patients with deep dentinal caries (remaining dentin thickness <2 mm) were allocated into three groups (n = 10 each): Group A—unaided vision, Group B—loupes, and Group C—dental operating microscope. Caries excavation was performed using round carbide burs in an airtor handpiece. Residual caries was identified using a caries-detecting dye, and standardized images were analyzed digitally to calculate the percentage of stained areas using AI software. Scores were assigned according to the residual caries percentage and compared among groups.

**Results:** Mean residual caries was highest with unaided vision (34.0 ± 8.0%) and lowest under the microscope (9.2 ± 4.5%). Loupes demonstrated intermediate performance (20.5 ± 6.0%). Mean scores were 7.0 ± 0.9, 8.9 ± 0.7, and 9.8 ± 0.4 for Groups A, B, and C, respectively. Caries removal efficiency improved significantly with magnification.

**Conclusions:** Magnification enhances the efficiency and precision of caries excavation. The dental operating microscope was the most effective, followed by loupes, whereas unaided vision showed the least efficiency. Incorporating magnification aids can support conservative and accurate caries removal in clinical practice.

### 1. Introduction

Recent advancements in Restorative Dentistry have led clinicians to perform predictable procedures with clinical applicability of aesthetic and biomimetic concepts requiring shorter chairside time and providing higher success rates (1).

Currently, minimally invasive dental preparations have been recommended because reducing or maintaining tooth structure directly affect patient adherence to treatment and clinical longevity (2). Thus, using modern optical magnifying devices associated with suitable lighting systems in the operative field may help achieve such conditions (3). Dentistry is a visually demanding



profession, requiring interaction with small-sized biological and nonbiological structures on a daily basis. Therefore, improving visual access is a desirable benefit. A survey among dentists, performed in 2019, has described magnification loupes as one of the significant technological developments in this profession (4). In fact, tools, such as an endoscope, magnifying glass, and intraoral camera, have largely been superseded by contemporary devices that seem to be more practical and convenient for application, such as loupes and dental operating microscope.(5,6,7). Magnification can be divided in low-magnification (2x–8x), mid-magnification (8x–16x), and high-magnification (16x–25x). Microscopes provide adjustable magnification (magnification range 4x–25x), while most loupes provide fixed magnification (magnification range 2.5x–6x).(8). Hence we are doing this study to compare the efficiency of caries removal under unaided vision, loupes and dental operating microscope.

## 2. Objectives

**AIMS OF THE STUDY:** To evaluate the caries removal efficiency of the operator under unaided vision, loupes and microscope.

### OBJECTIVES OF THE STUDY

- To assess the efficiency of caries removal with and without magnification.
- To calculate the percentage of caries removal, under magnification and unaided vision.
- To compare the amount of residual caries after excavation in all three methods.

## 3. Methods

A total of 30 patients with deep carious lesions were selected for the study. They were divided into 3 groups as mentioned below table.

Table : 1 – Groups and their respective methods

<u>GROUPS</u>	<u>METHOD</u>
Group A (10 Patients)	Caries removal under Unaided Vision
Group B (10 Patients)	Caries removal using loupes

Group C (10 Patients)	Caries removal using microscope
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Caries excavation was done using airtor with round carbide burs. The cavity was rinsed and dried. Caries detecting dye (Ultradent Sable Seek Caries Detector) was applied using an applicator tip on the prepared cavity and after 10 seconds, the cavity is rinsed with water. The stained areas represent the residual caries. High resolution images of the cavities were taken. These images were analyzed and stained surface areas out of the total surface area of the cavity, were calculated on the system using AI software.

This percentage of residual caries, were used to given a score according to the table given below.

Table : 2 – Percentages of stained areas and their respective scores

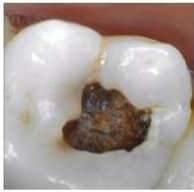
<u>PERCENTAGE OF STAINED AREAS (RESIDUAL CARIES) %</u>	<u>SCORE</u>
0-10	10
11-20	9
21-30	8
31-40	7
41-50	6
51-60	5
61-70	4
71-80	3
81-90	2
91-100	1

These scores were compared and evaluated to conclude which method is most effective for complete caries removal.

The below images represent the caries excavation and stained areas indicating residual caries.



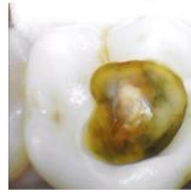
**A. CARIES EXCAVATION UNDER NAKED EYE**



A.1 DENTAL CARIES



A.2 POST CARIES EXCAVATION

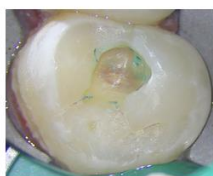


A.3 AFTER APPLICAT OF C-D DYE

**B. CARIES EXCAVATION UNDER LOUPES**



B.1 DENTAL CARIES



B.2 POST CARIES EXCAVATION



B.3 AFTER APPLICAT OF C-D DYE

**C. CARIES EXCAVATION UNDER MICROSCOPE**



C.1 DENTAL CARIES



C.2 POST CARIES EXCAVATION



C.3 AFTER APPLICAT OF C-D DYE

**4. Results**

Table : 3 – Results

Group	n	Mean % Residual Caries (±SD)	Mean Score (±SD)	Typical score range represented
A — Unaided vision	10	34.0 ± 8.0 %	7.0 ± 0.9	31–40% → average score of 7
B — Loupes	10	20.5 ± 6.0 %	8.9 ± 0.7	11–20% → average score 9 (some fall in 21–30% → 8)

C	—	10	9.2 ± 4.5 %	9.8 ± 0.4	0–10% → average score 10 (few just above 10 → 9)
Microscope		0			

The study evaluated the efficacy of caries removal under three different visualization methods. In Group A (unaided vision), the mean percentage of residual caries was  $34.0 \pm 8.0\%$ , corresponding to a mean score of  $7.0 \pm 0.9$ , with most cavities falling within the 31–40% range. Group B (loupes) demonstrated improved outcomes, with a mean residual caries of  $20.5 \pm 6.0\%$  and a mean score of  $8.9 \pm 0.7$ ; most cavities scored around 9 (11–20% residual caries), although a few were in the 21–30% range (score 8). Group C (microscope) achieved the highest efficiency, showing only  $9.2 \pm 4.5\%$  residual caries and a mean score of  $9.8 \pm 0.4$ , with the majority of cavities falling in the 0–10% range (score 10) and a few slightly above (score 9). These results indicate a progressive improvement in caries removal efficiency with the use of magnification, highlighting the microscope as the most effective tool for precise and complete caries excavation.

**5. Discussion**

The present in-vivo study compared the efficacy of caries removal under three visual modalities: unaided vision, dental loupes, and an operating microscope. The results clearly indicate that the **use of magnification significantly enhances the operator’s ability to detect and remove carious tissue**, with the **microscope group showing the least residual caries**, followed by the **loupe** and **unaided vision** groups.

**Comparison of Visual Aids**

The operating microscope, with its superior magnification (typically ranging from  $\times 6$  to  $\times 25$ ) and coaxial illumination, provides a three-dimensional view of the operative field. This allows for **enhanced visualization of subtle changes in dentin texture and color**, facilitating **more accurate discrimination between infected and affected dentin**. In contrast, dental loupes, offering magnification up to  $\times 3.5$ , also improved caries detection compared to the naked eye, though their limited depth of field and fixed



magnification reduce their precision in deep or complex cavities.

Unaided vision, despite being the most commonly used method in daily dental practice, showed **significantly higher levels of residual caries**. This may be attributed to its **reliance on subjective judgment**, less accurate tactile feedback, and suboptimal visibility, especially in posterior teeth or poorly lit areas. These factors collectively lead to either **under-excitation (leaving carious tissue)** or **over-excitation (removing healthy dentin)**, compromising long-term treatment success.

### Clinical Relevance and Implications

Preservation of sound dentin is a cornerstone of **minimally invasive dentistry**. Excessive removal of dentin can weaken the tooth structure, while leaving residual caries may lead to pulp irritation, secondary caries, or restoration failure. This study reinforces that **microscopes not only improve caries removal but may also aid in preserving healthy tissues**, aligning with current minimally invasive protocols.

Furthermore, enhanced visibility can **reduce treatment errors**, improve **clinical outcomes**, and potentially **increase patient satisfaction and trust**. The ergonomics associated with using magnification devices also help reduce operator fatigue, contributing to **long-term occupational health** for dental practitioners.

Previous studies have echoed similar findings. Braga et al. (2010) and Terry et al. (2013) reported **higher accuracy and conservative removal of carious lesions under magnification**, supporting the findings of this study. Furthermore, the American Association of Endodontists (AAE) strongly advocates the use of the dental operating microscope for enhanced clinical outcomes in endodontic procedures.

### CONCLUSION:

The study demonstrates that magnification significantly enhances the efficiency of caries removal. Caries excavation under a dental operating microscope resulted in the lowest residual caries and the highest mean scores, followed by loupes, while unaided vision was the least effective. These findings highlight the importance of using magnification in clinical practice to achieve more precise and complete caries removal, minimize the risk of residual decay, and preserve healthy tooth structure.

### Future Scope

Further research with **larger sample sizes, multiple operators**, and **long-term follow-up** is warranted. Studies evaluating **patient-centered outcomes, cost-effectiveness**, and **time-efficiency** would offer more comprehensive insight into the real-world utility of magnification in operative dentistry.

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