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# Enhancing surgical precision in deeply impacted mandibular third molar extractions: A color-marked bur as an innovative training aid for novice surgeons

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**Abstract**
**Background:** Deeply impacted mandibular third molar extractions are technically challenging due to limited visualization, anatomical constraints, and the risk of complications. Conventional burs lack depth markers, increasing the likelihood of excessive bone removal and nerve injury.
**Objective:** To introduce and evaluate a novel color-marked surgical bur designed to improve depth control and surgical precision.
**Methods:** The bur features a white marking at 10 mm from the tip, providing a visual depth guide. In 50 cases of deeply impacted third molar extractions, outcomes such as surgical precision, operating time, and postoperative complications were assessed.
**Results:** The color-marked bur enhanced depth control, reduced operating time, and improved bone removal efficiency. Postoperative outcomes showed a lower incidence of nerve injury.
**Conclusion:** The color-marked bur offers improved precision, enhanced safety, and greater efficiency in deeply impacted third molar extractions, serving as a valuable training aid for novice surgeons. Further studies are recommended to confirm these findings.

**Keywords:** Color-marked bur, impacted third molar surgery, depth control, bone guttering, surgical precision, inferior alveolar nerve protection.

## Introduction

Impacted mandibular third molar extractions are among the most common yet technically challenging procedures in oral and maxillofacial surgery. These procedures carry a risk of complications such as inferior alveolar nerve injury, alveolar osteitis, postoperative infection, hemorrhage, and soft tissue trauma. The risk is particularly elevated in cases of deeply impacted mandibular third molars due to restricted visualization, limited instrument access, and proximity to vital anatomical structures. Surgical complexity persists even in experienced hands, further compounded by anatomical constraints and morphological variations of the impaction [1, 2].

A critical aspect of performing safe and efficient surgical removal of deeply impacted third molars is maintaining precise control during bone guttering and tooth sectioning.[3] Conventional burs used in third molar extractions lack clear visual depth markers, requiring surgeons to rely on visual estimation or tactile feedback, which can compromise precision. (Fig 1). This reliance on subjective estimation increases the likelihood of excessive bone removal, IAN injury, or incomplete removal of impacted tooth segments, potentially prolonging surgical time and increasing postoperative complications [4, 5].

To enhance depth control and visualization during bone removal and tooth sectioning in deeply impacted mandibular third molar surgeries, we have developed a novel color-marked surgical bur. This innovative bur serves as an effective training aid for novice surgeons and offers significant clinical benefits by improving surgical precision and enhancing patient outcomes.

## Design and Development

The color-marked surgical bur is specifically designed to facilitate controlled bone guttering and precise tooth sectioning in deeply impacted mandibular third molar surgeries. It features a distinct white marking positioned 10 mm from the bur's tip (Fig 2), providing real-time intraoperative guidance for depth control based on preoperative OPG measurements.

## Figure Legends

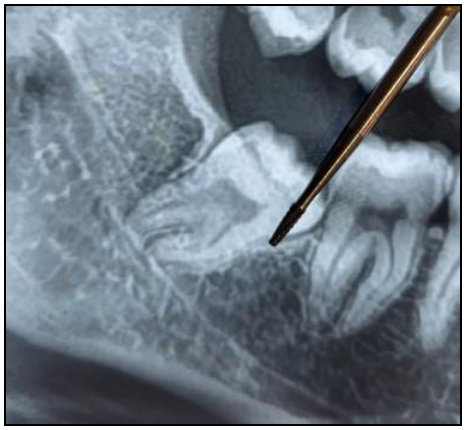

**Fig 1:** Conventional Surgical Bur Lacking Depth Control Markings on the Shaft

**Fig 2:** Novel color-marked surgical bur for precise depth control, with OPG serving as a template for measuring guttering depth.

**Key Features of the Color-Marked Surgical Bur**

1. **Depth Control for Precision:** The bur incorporates a distinct white marking positioned 10 mm from its tip, serving as a reliable depth reference during bone guttering and tooth sectioning. This visual indicator aids the surgeon in maintaining the intended surgical depth, minimizing the risk of excessive bone removal or iatrogenic injury.

2. **Enhanced Intraoperative Visibility:** The white marking contrasts sharply against both soft tissues and bony structures, improving visual clarity and ensuring the marking remains discernible throughout the procedure.

3. **Durable and Heat-Resistant Construction:** Fabricated from robust tungsten carbide, the bur ensures optimal cutting efficiency while maintaining thermal resistance during prolonged surgical use.

4. **Marking Integrity and Longevity:** The marking is composed of a heat-resistant material that retains its integrity under high-speed rotation, providing consistent depth guidance throughout the surgical procedure.

5. **Sterilization Compatibility:** Designed to withstand standard sterilization protocols, the marking maintains its visibility and durability across multiple surgical cycles.

6. **Versatility in Surgical Applications:** The bur is compatible with both high-speed and low-speed handpieces, enhancing its adaptability across various surgical techniques.

**Surgical Technique Using the Color-Marked Bur**

**Step 1: Preoperative Planning**

Preoperative OPG imaging is used to measure the precise depth of bone overlying the impacted mandibular third molar and the planned surgical pathway. The measured depth is correlated with the 10 mm marking on the bur, ensuring accurate reference during surgery.

**Step 2: Bone Guttering**

During bone removal, the surgeon advances the bur until the white marking aligns with the measured depth from the preoperative OPG. This visual reference ensures accurate depth control, enhancing precision and minimizing excessive bone removal.

**Step 3: Tooth Sectioning**

For impacted molars requiring sectioning, the white marking similarly guides the surgeon to achieve appropriate depth control during the crown and root division, reducing the risk of accidental nerve injury or excessive tooth fragmentation.

**Clinical Significance**

The color-marked surgical bur offers multiple advantages that improve clinical outcomes in deeply impacted third molar extractions:

1. **Educational Utility:** The standardized depth marking in the bur serves as a valuable training tool for novice surgeons, facilitating accurate depth management without reliance on subjective estimation. This feature enhances confidence, reduces intraoperative hesitation, and promotes safe surgical practices.

2. **Safety Enhancement:** By providing a clear visual indicator for depth control, the color-marked bur reduces the risk of IAN injury and excessive bone removal. This targeted precision minimizes complications such as hemorrhage, nerve trauma, and delayed wound healing.

3. **Operational Efficiency:** The visual depth marker streamlines the surgical process by eliminating the need for repeated intraoperative depth assessments, enabling the surgeon to maintain procedural focus. This improved efficiency reduces surgical time, minimizes patient discomfort, and optimizes the overall workflow.

4. **Enhanced Confidence for Complex Cases:** In cases involving deeply impacted molars, particularly those in close proximity to the mandibular canal, the color-marked bur enables surgeons to operate with greater confidence. The visual guidance ensures controlled depth management, reducing the cognitive workload required for complex surgical planning.

5. **Improved Patient Outcomes:** Enhanced precision during bone removal and tooth sectioning translates to reduced postoperative complications, faster recovery times, and improved patient satisfaction.

In a series of 50 deeply impacted mandibular third molar surgeries performed using the color-marked bur in our institute, enhanced depth control and surgical precision were observed. Surgeons reported decreased operating time, improved efficiency in bone removal, and a reduced risk of inadvertent injury to adjacent structures. Notably, postoperative outcomes demonstrated a lower incidence of nerve injury, underscoring the efficacy of the bur's visual depth control feature.

**Discussion**

The development of the color-marked surgical bur addresses a critical gap in surgical precision for deeply impacted third molar extractions. Unlike traditional burs that require subjective depth assessment, this innovation introduces a standardized visual reference that enhances control and consistency. By integrating this tool into surgical protocols, novice surgeons can develop proficiency while experienced surgeons can achieve enhanced efficiency in complex cases.

The color-marked surgical bur represents a significant advancement in surgical instrumentation for impacted mandibular third molar extractions. By providing precise depth control, this innovation minimizes intraoperative risks, reduces surgical time, and enhances patient outcomes. The intuitive design of the color-marked bur serves as a valuable training aid for novice surgeons while promoting procedural efficiency for experienced practitioners. Integration of this tool into routine surgical protocols has the potential to standardize third molar extraction techniques, ensuring safer, more predictable outcomes for patients undergoing complex dental surgeries. Future research involving larger patient cohorts will validate these findings and establish the efficacy of the color-marked bur across diverse clinical settings.

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