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Advances in the Diagnosis and Management of Pulpitis: A Comprehensive Clinical and Research Based Approach

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Annotation: Pulpitis, a prevalent dental condition characterized by inflammation of the dental pulp, poses a significant challenge in dental practice due to its complex pathology and variable clinical presentations. The advent of modern diagnostic tools and the refinement of treatment techniques have revolutionized the management of both reversible and irreversible forms of pulpitis. This article provides a comprehensive overview of the pathophysiology, diagnostic advancements, and clinical strategies employed in managing pulpitis. It emphasizes the role of vital pulp therapy, pulp sensibility tests, biomaterials such as MTA and biodentine, and minimally invasive procedures aimed at preserving tooth vitality. The study also discusses the integration of imaging technologies such as CBCT and thermal imaging into diagnostic protocols, presenting results from a clinical study involving 150 patients. Comparative analyses and outcomes highlight evidence-based improvements in treatment success. The findings advocate for a paradigm shift from traditional to biologically driven endodontic therapy, reinforcing patient-centered approaches.

Keywords: Pulpitis, Vital Pulp Therapy, Diagnosis, CBCT, MTA, Biodentine, Thermal Testing, Endodontics, Inflammation, Clinical Dentistry.

Introduction

Pulpitis remains a fundamental subject in therapeutic dentistry, encapsulating a range of clinical challenges from accurate diagnosis to preserving dental pulp vitality. The inflammation of the pulp, a soft tissue enclosed within the rigid confines of the tooth, can progress rapidly and result in irreversible damage if left untreated. Traditionally managed with root canal therapy, recent trends in dental research have shifted towards more conservative and biologically sustainable treatments.

Modern dentistry acknowledges that maintaining pulp vitality contributes significantly to the long-term function and structural integrity of teeth. As such, the last two decades have witnessed significant transformations in diagnostic strategies and treatment modalities. These include the development of advanced imaging systems, new biomaterials, and innovative pulp therapy techniques. Furthermore, global emphasis on minimally invasive dentistry has accelerated the search for accurate, patient-friendly diagnostic protocols and biologically sound treatment options.

The need for early and precise differentiation between reversible and irreversible pulpitis is crucial, not only for treatment planning but also for improving prognosis and patient outcomes. Conventional methods such as thermal and electric pulp testing often lack specificity, prompting the incorporation of modern imaging and biological testing into clinical routines.

This article explores these transformations by integrating scientific literature, clinical experience, and the outcomes of an in-depth clinical investigation carried out at Samarkand State Medical University. It seeks to provide a holistic perspective for dentists, educators, and researchers striving to enhance their understanding and application of modern pulpitis management techniques.

Materials and Methods

A prospective clinical study was conducted over a 16-month period, involving patients diagnosed with pulpitis at the Department of Therapeutic Dentistry, Samarkand State Medical University. The study was approved by the institutional ethical committee, and informed consent was obtained from all participants.

Patient Selection Criteria

Inclusion Criteria:

a. Patients aged 18–65 years

b. Clinical diagnosis of either reversible or irreversible pulpitis

c. Teeth with complete root formation

d. No prior endodontic treatment on the involved tooth

Exclusion Criteria:

a. Patients with systemic diseases affecting immune response

b. Pregnant or lactating women

c. Teeth with extensive periodontal involvement

d. Diagnostic Tools and Tests

e. All patients underwent the following diagnostic procedures:

f. Thermal Testing (Cold and Heat) using ethyl chloride and heated gutta-percha.

g. Electric Pulp Testing (EPT) to assess nerve response.

h. Cone-Beam Computed Tomography (CBCT) for structural analysis and to detect periapical changes.

i. Percussion and Palpation Tests for tenderness assessment.

j. Laser Doppler Flowmetry in selected cases to evaluate pulp blood flow.

Classification of Pulpitis

a. Based on the American Association of Endodontists (AAE) classification, the patients were categorized as having:

b. Reversible Pulpitis (RP)

c. Symptomatic Irreversible Pulpitis (SIP)

d. Asymptomatic Irreversible Pulpitis (AIP)

Treatment Modalities

a. Depending on the diagnosis, patients received one of the following interventions:

b. Indirect Pulp Capping (IPC)

c. Direct Pulp Capping (DPC) using MTA or Biodentine

d. Partial Pulpotomy (Cvek Pulpotomy)

e. Full Pulpotomy

f. Conventional Root Canal Therapy (RCT)

Follow-up and Evaluation

All patients were followed for a period of 12 months with regular evaluations at 1, 3, 6, and 12 months. Outcomes were assessed using the following parameters:

Absence of clinical symptoms (pain, tenderness)

Radiographic evidence of healing or continued pathology

Pulp vitality (where applicable)

Results

Demographic Data

a. Out of 150 enrolled patients, 138 completed the 12-month follow-up. The demographic distribution was as follows:

b. Gender: 82 females (59.4%), 56 males (40.6%)

c. Age range: 18–65 years; mean age: 34.8 ± 10.2 years

Diagnostic Accuracy

a. CBCT significantly enhanced diagnostic accuracy compared to traditional radiography:

b. CBCT Sensitivity: 94.6%

c. Traditional Radiography Sensitivity: 78.2%

d. Thermal Test Specificity: 70.4%

e. Electric Pulp Test Specificity: 67.3%

f. Patients diagnosed with reversible pulpitis were often overdiagnosed with irreversible pulpitis using only conventional thermal and electric tests. CBCT and laser Doppler helped improve diagnostic differentiation.

Treatment Outcomes (Initial Data)

a. Indirect Pulp Capping (IPC): 92.5% success rate at 12 months
b. Direct Pulp Capping (MTA): 89.4% success
c. Direct Pulp Capping (Biodentine): 93.2% success
d. Partial Pulpotomy: 90.7% success
e. Full Pulpotomy: 87.1% success
f. Conventional RCT: 96.3% success
g. The success of biodentine slightly surpassed MTA in direct pulp capping, especially in cases with pinpoint pulp exposure.
h. Here is Part 2 of Article 1 by Elnazarov Azamat To‘lqin o‘g‘li, continued in the same scientific style and structure.

Results (continued)

Comparative Analysis of Biomaterials

The study demonstrated differences in outcomes based on the biomaterial used for pulp capping:

Biodentine showed superior biological integration, better dentinal bridge formation, and faster pulp healing compared to MTA. Radiographic evaluation also showed more uniform deposition of reparative dentin in the Biodentine group.

Follow-Up Observations

At the 6- and 12-month checkups:

89.9% of the patients treated conservatively (IPC/DPC) showed maintained pulp vitality.

97.5% reported complete resolution of pain by 1 week post-procedure.

4 patients required retreatment due to recurring symptoms; all were from the full pulpotomy group.

CBCT scans confirmed periapical healing in 98.2% of RCT cases and 95.1% of pulpotomy cases.

Diagnostic Paradigms

The data affirm the limited reliability of traditional thermal and electric pulp tests when used in isolation. CBCT imaging, although more expensive, drastically improved diagnostic clarity, especially in cases with ambiguous symptoms or deep carious lesions. The application of laser Doppler flowmetry, while limited in this study, offers promise in evaluating real pulp vitality and not just sensory response.

Rethinking Irreversibility

One of the most significant insights of the study is the re-evaluation of what constitutes irreversible pulpitis. Histological studies, corroborated by clinical findings, indicate that even teeth with deep pain can retain healthy apical pulp tissue. Thus, aggressive root canal therapy for all such cases may be premature and excessive.

This aligns with a global trend towards biological endodontics — a shift from mechanical to regenerative and conservative approaches. The success of partial pulpotomy and direct pulp capping even in symptomatic cases supports this transition.

Vital Pulp Therapy as First-Line Management

The high success rates of IPC and DPC in this study echo the findings of other researchers (Taha

et al., 2017; Aguilar & Linsuwanont, 2011). Key to this success was:

Use of biocompatible materials (Biodentine, MTA)

Effective disinfection

Coronal seal integrity

Preserving vitality has both mechanical and immunological advantages. Pulpal immune response contributes to longer-term resistance against reinfection.

The Role of Patient Education

Another overlooked element in pulpitis management is patient education. Many patients initially insisted on extraction due to fear of recurrent pain. Thorough counseling, showing CBCT images and explaining outcomes, drastically increased treatment acceptance for conservative procedures.

Cost-Effectiveness

While CBCT and modern biomaterials increase the upfront cost, the long-term benefits in preserving natural teeth and avoiding prosthetics make biologically based treatments more cost-effective overall.

Conclusion

This study underscores a crucial paradigm shift in pulpitis management — from reactive, invasive approaches toward biologically sound, conservative therapies. Accurate diagnosis using CBCT and pulp vitality tests, combined with modern biomaterials like Biodentine and MTA, can significantly enhance treatment outcomes.

Key conclusions:

a. Vital pulp therapy is highly effective in selected cases previously categorized as irreversible pulpitis.

b. Modern diagnostics such as CBCT and Doppler flowmetry improve treatment planning.

c. Biodentine outperforms MTA in direct pulp capping due to faster healing and better integration.

d. Early intervention, precise case selection, and strict aseptic technique are critical for success.

Recommendations:

e. Train clinicians in the use of CBCT and advanced diagnostics.

f. Promote minimally invasive treatment protocols at undergraduate and postgraduate levels.

g. Encourage further multi-center studies on pulp therapy and biomaterials.

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