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Position Statement on Deep Caries Management & Vital Pulp Therapy

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Indian Endodontic Society: Position statement for deep caries management and vital pulp therapy procedures

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ABSTRACT

This position statement on Vital Pulp Therapy (VPT) procedures, endorsed by the Indian Endodontic Society (IES), aims to provide a comprehensive perspective on the management of deep caries and exposed pulp within the realm of endodontic practice. VPT serves as the cornerstone of modern endodontics, particularly with advancements in biomaterials and regenerative methods. Its primary goal is to preserve the vitality of the dental pulp while simultaneously promoting the overall health of the tooth and periapical structures. In the diverse and dynamic landscape of Indian dentistry, the IES recognizes the need for a position statement tailored to the unique needs and challenges encountered by dental practitioners in India. This position statement presents evidence-based recommendations on VPT, considering not only international perspectives from reputed international organizations, but also the distinct factors influencing dental care in India. Drawing upon the collective expertise of the expert committee, this statement addresses key aspects of VPT, including patient selection, accurate diagnosis, effective treatment techniques, and follow-up protocols. While conventional endodontic therapy remains important, IES emphasizes the significance of VPT in well-selected cases. The statement also addresses areas of potential conflict, identifies avenues for future research, and presents the current status based on the best available scientific evidence. By providing a comprehensive overview of VPT, this position statement aims to serve as a valuable guide for dental practitioners, educators, and researchers, fostering optimal patient care and advancing the field of endodontics in India through evidence-based practice and continuous learning.

Keywords: Deep caries, direct pulp capping, full pulpotomy, partial pulpotomy, selective excavation


SECTION 1: INTRODUCTION

The field of endodontics is presently undergoing a paradigm shift when it comes to the management of deep caries and exposed pulp with its focus gradually shifting towards minimally invasive biological procedures also termed Vital Pulp Therapy (VPT) procedures.^[1,2] VPT includes a range of treatment modalities directed towards maintaining all or part of pulpal vitality while managing

deep (i.e., caries reaching the inner quarter of dentine) and extremely deep carious lesion (i.e., caries penetrating the entire thickness of the dentine).^[1,3] This position statement limits itself to the management of deep and extremely deep carious lesions, as the management of superficial caries is relatively forthright with no conflicting opinions.

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The use of VPT in managing deep caries and exposed pulp has gained popularity recently. This is due to mounting scientific evidence that conventional treatment methods can be at times aggressive, inadequately performed, and deemed as overtreatment.^[4,5] Furthermore, advancements in our comprehension of the caries disease process and its pathogenesis, as well as the regenerative potential of pulp and the availability of new bioactive capping materials, have further spurred this trend.^[3]

Historically, our conventional knowledge of caries as an infectious disease led most clinicians to adopt complete or nonselective caries removal techniques to eradicate all the infected or contaminated tissue. This approach often resulted in unnecessary removal of healthy hard tissue thereby increasing the risk of pulpal exposure.^[6] With the advancements in our understanding of caries, it is evident now that it is possible to manage it by rebalancing the cariogenic activity of dental biofilms without entirely eliminating the microorganisms.^[7-9] This insight has led to an alteration in our approach for handling deep caries, which involves a shift from nonselective removal of caries toward a selective/stepwise excavation methods.^[10,11]

For the management of carious pulpal exposure, the caries excavation technique has a limited significance, as pulpal exposure is unavoidable in such cases. The main point of contention remains the amount of pulpal tissue removal needed to attain the objective of a fully functional tooth devoid of symptoms, with healthy periapical tissues. Pulpectomy has been the standard of care for managing carious pulpal exposures associated with irreversible pulpitis. However, recent knowledge suggests that carious exposure-induced pulpitis is compartmentalized.^[12] Hence, implying, that the histological changes associated with irreversible pulpitis, such as necrosis and bacterial colonization, are restricted to the site of carious exposure.^[13,14] This pathophysiological basis behind the histological evidence can be traced back to Van Hassel's classic 1971 study, which debunked the controversial pulp strangulation theory.^[15,16] The study demonstrated that inflammation-induced increase in intra-pulpal pressure is a local phenomenon limited to the site of irritation and does not involve the entire pulp.^[15,17] Multiple clinical studies have also demonstrated that if the inflamed coronal pulp is removed, the remaining pulp tissue is capable of healing if a suitable environment is provided.^[18,19] These findings question the “irreversibility” of pulpal disease and the concept of the irreparably damaged pulp tissue, necessitating better diagnostic tools and terminology going forward.

Exposed pulp, which was once considered a doomed organ,^[20] is now viewed as a tissue capable of repair and

regeneration if treated appropriately. However, when it comes to the implementation of principles of minimally invasive endodontics in clinical practice, the attitude of the treating clinician and the management approach often differ among the clinicians. A recent upsurge in the number of publications validating the success of VPT has not yet translated into clinical application of these procedures at a larger scale. Handling exposed pulpal tissue has been known to often make clinicians feel stressed.^[21,22] In addition, several national and international surveys indicate that practitioners often deviate from the established guidelines while managing a carious pulpal exposure chairside. There is a variation in the treatment protocol followed by clinicians depending on their clinical experience, geographical location, and symptoms of patients.

The Indian Endodontic Society (IES) recognizes the potential for Vital Pulp Therapy (VPT) in modern endodontic practice in India, to have improved patient-centric outcomes. Research has shown that VPT is mostly a one-visit procedure, conservative, cost-effective, and preserves pulp vitality, immunological and proprioceptive function of dental pulp while delaying the restorative cycle.^[1,23] VPT can be an ideal treatment option for India, where the oral disease burden is high.^[24] However, it is crucial to note that not all cases are suitable for VPT, and careful patient selection and case assessment are necessary for the best possible results. To this end, the IES has developed the following guidelines for the management of deep and extremely deep carious lesions, based on the best available scientific evidence. The guidelines provide referenced suggestions for decision-making and case selection, with the goal of improving patient outcomes and standardizing treatment protocols. It is important to note that these guidelines will be regularly updated as our knowledge of pulp biology and long-term treatment outcomes of VPT continue to evolve.

SECTION 2: DIAGNOSTIC TERMINOLOGIES USED

Diagnostic terminology for Vital Pulp Therapy: Terminology and components

Making an accurate diagnosis of the precise disease state related to caries is challenging and complex. For making an accurate diagnosis and hence the right treatment strategy, multiple factors should be taken into consideration simultaneously. A provisional diagnosis of the extent of caries and the pulpal status for VPT procedures, should be based on a combination of preoperative symptoms of the patient (subjective and objective), radiographic depth of lesion, and intraoperative assessment.

Preoperative signs and symptoms

This includes both subjective (reported by the patient on thorough history taking) and corroborated by the clinician

using objective tests (Electric pulp test [EPT] and Cold sensibility test).

Subjective assessment

The most important and common subjective presentation of a pulpal involvement is the complaint of pain. Judicious questioning about the following parameters regarding pain can aid the clinician in developing a tentative diagnosis. The three key attributes of pain to be ascertained during the history-taking would be:

- Kind of pain: Sharp, piercing, and lancinating versus dull, boring, or gnawing pain
- Location of pain: Localized versus diffuse pain
- Duration of pain: Short and specific to stimuli versus spontaneous, lingering, or nocturnal pain.

Objective assessment

The accurate diagnosis of the true histological status of the pulp is clinically difficult and challenging. Pulp vascularity tests such as pulse oximetry and laser Doppler flowmetry are not yet clinically available as affordable practical chairside aids and hence a clinician relies more on neural sensibility tests such as thermal and EPTs as the primary means to test the status of pulp. Among all these tests, the cold test has the highest diagnostic accuracy and hence is recommended as the primary pulp testing method.^[25,26]

On the basis of the above-mentioned objective and subjective assessment, we propose classifying the patients as follows:

- A. Asymptomatic: Patient reporting with no symptoms and is clinically asymptomatic.
- B. Mild symptomatic (indicative of reversible pulpal changes)
 - Symptoms are experienced only when stimulus is applied and lasts for a short duration
 - Cold/EPT test elicits a short sharp pain that disappears rapidly once the stimulus is removed.
- C. Severe symptomatic (indicative of irreversible pulpal changes)
 - Patient reporting with symptoms that are severe in intensity, i.e. Visual Analog Scale score >7
 - The symptoms may persist for longer periods, even after the stimulus is removed. The symptoms could be unprovoked/spontaneous/lying down
 - Cold/EPT test elicits an excruciating painful response that lingers on even after the stimulus is removed.

Radiographic depth of caries

To assess the depth of caries both periapical and bitewing (for proximal lesions) radiograph may be used.^[3]

- a. Caries within 3/4th of the depth of dentin
- b. Deep Caries: Radiographically <3/4th of dentin with the presence of a layer of radiodense dentin

- c. Extremely Deep: Radiographically penetrating through the entire thickness of dentin with no layer of radio-dense dentin between the carious lesion and pulp.

Intraoperative diagnosis

This is the cornerstone of the practice of Vital Pulp Therapy procedures. Caries excavation should be considered a diagnostic procedure prior to final diagnosis of pulpal disease. The diagnosis of the pulpal condition can only be made once the caries is excavated, allowing visual examination of dentin and exposed pulp (in cases of pulpal exposure). Along with the identification of depth of dentinal caries, visual examination is an extremely useful clinical aid for determining the effect of the carious lesion on pulp. This involves visual examination of the deepest portion of dentin, and in cases with exposed pulp, observation of time taken for hemostasis of pulpal bleeding, and observation of the status of exposed pulp. It is highly recommended to use magnification (with loupes of magnification $\times 2.5$ – $\times 4.0$ or the use of a dental operating microscope) for the visual examination with good illumination.

Intraoperative examination involves visual examination of the following tissues:

Dentin

This involves visual inspection of remaining dentin (*in the deepest portion*) after caries excavation and the dentinal walls surrounding the deepest portion. Depending on the consistency, it could be classified as one of the following types:^[3]

- Soft dentin (Previously referred as Infected Dentin): As the word suggests, it is soft and gets deformed under pressure and can be scooped out easily with minimum resistance
- Firm dentin (previously referred as Affected Dentin): While it is amenable to excavation using hand instruments, it needs some pressure for removal
- Hard Dentin (Normal Dentin): It is resistant to penetration with hand instruments and a scratchy sound is produced when a probe is run across the wall.

Time taken for hemostasis after pulp exposure

Clinical observation of these criteria gives an indication of the level of pulp inflammation.

- Hemostasis should be ideally achieved in approximately 5 min time by applying a cotton/gauze pellet soaked with 2.5% NaOCl
- Failure to achieve hemostasis after pulpal bleeding indicates pulpal tissue that is irreversibly inflamed. The operator should proceed to the next level of treatment plan [Table 1].



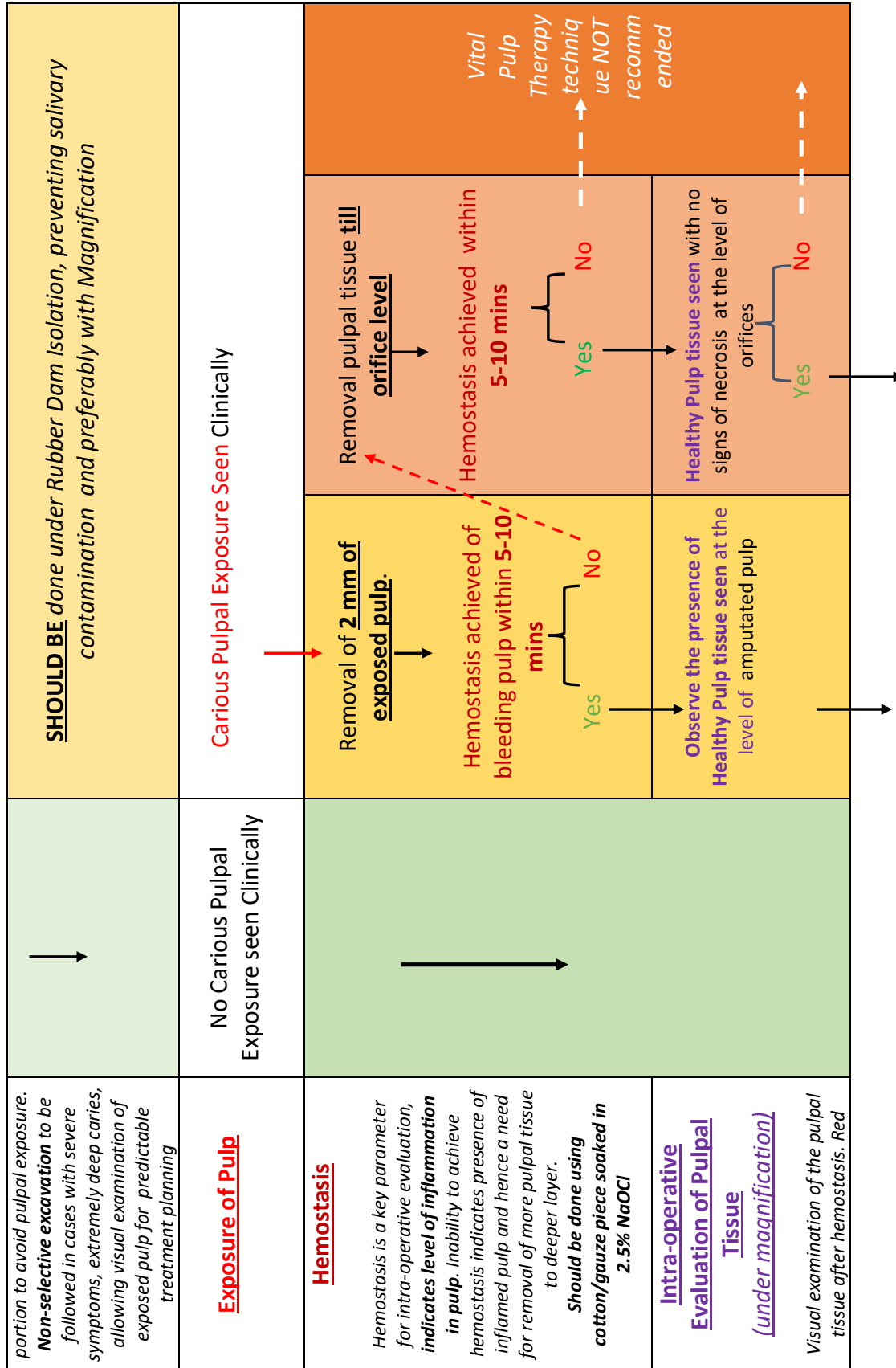


TABLE 1: DECISION MAKING FLOW CHART FOR MANAGEMENT OF DEEP CARIOUS LESIONS

<div> <div>Key Determining Factors and recommendations</div> </div>						
<div> <div>Radiographic Depth</div> <div> Assess the lesion depth as seen on the intra-oral radiograph . Bite-wing preferred for proximal lesions </div> </div>	<div> <div>Deep caries</div> <div>(more than 3/4th of dentinal involvement with presence of layer of radiodense remaining dentin)</div> </div>			<div> <div>Extremely Deep caries</div> <div>(Penetrating through the entire thickness of dentin with no layer of remaining dentin)</div> </div>		
<div> <div>Signs & Symptoms</div> <div> Symptoms, include both subjective (reported by the patient) and objective tests done chair-side (Cold sensibility/Electric Pulp test test) </div> </div>	<div> <div>Asymptomatic</div> <div>(No Symptoms)</div> </div>	<div> <div>Mild Symptoms</div> <div>(mild in intensity, lasting for short duration, on stimulus only) Cold/EPT positive</div> </div>	<div> <div>Severe</div> <div>(severe intensity, spontaneous /long lasting) Exaggerated response to Cold/EPT</div> </div>	<div> <div>Asymptomatic</div> <div>(No Symptoms)</div> </div>	<div> <div>Mild</div> <div>(mild in intensity, lasting for short duration, on stimulus only) Cold/EPT positive</div> </div>	<div> <div>Severe</div> <div>(severe intensity, spontaneous /long lasting) Exaggerated response to Cold/EPT</div> </div>
<div> <div>Caries Excavation Method</div> <div> Selective excavation for Deep caries with no/mild symptoms, leaving behind caries in deepest </div> </div>	<div> <div>Selective Excavation</div> <div>(in deepest portion)</div> </div>		<div> <div>Non-Selective</div> <div>Excavation exposing Pulp</div> </div>			





Homogeneous tissue indicates healthy tissue. Presence of necrotic borders/ yellowish hue of pulp indicative of necrosis.	↓	Yes ↓	↓	↓
<u>Provisional Diagnosis</u> Basis combined inputs from Patient symptoms, radiographic depth and intra-operative evaluation	Reversible Pulpitis	Partial Irreversible pulpitis (confined to coronal pulp)	Complete Irreversible pulpitis	
<u>Treatment Modality to be Rendered</u> Removal of at least 2mm (or more) of pulpal tissue, based on clinical evaluation is recommended for symptomatic carious exposures. *Direct Pulp Capping may be opted for (latrogenic / small carious exposures with mild symptoms, provided hemostasis achieved at the site of exposure (Refer Table 3).	Indirect Pulp Capping (One-stage /stepwise)	Partial Pulpotomy*	Full Pulpotomy	Pulpectomy
<u>For Step by Step Treatment Protocol</u>	Refer Table 2	Refer Table 4	Refer Table 5	

Prognostic Variables To Be Considered In Addition

1. Availability of magnification – Yes/ No
2. Expertise level of operator – is the operator competent for handling of exposed pulp tissue or not? Yes/No
3. Is the caries restricted to only one surface (occlusal surface) of the tooth? Yes/No

“A negative answer to the above questions can have an impact on the favorability of treatment outcome. In such cases, Clinician may want to opt for the more invasive approach

Visual examination of pulpal tissue

This involves a visual examination of the pulpal tissue once the hemostasis is achieved. The pulpal tissue needs to be examined for red homogeneous tissue/presence of necrotic borders/yellowish hue of pulp or dark color of floor indicative of necrosis/presence of dentin microchips in pulp.^[14]

Classification of pulpal disease severity

On the basis of the above three diagnostic steps, the pulpal inflammatory status/conditions may be classified as:

- I. Normal pulp
- II. Reversible pulpitis:
 - A mild-to-moderate inflammatory condition of the pulp in which the pulp is capable of returning to the uninfamed state following removal of the stimuli
 - Removal of the noxious stimuli is the treatment of choice.
- III. Partial irreversible pulpitis (restricted to the coronal pulp)
 - A form of pulpitis in which the irreversible inflammatory changes of the pulp are restricted to the coronal pulp while the radicular pulp is capable of returning to a healthy state after removal of the noxious stimuli
 - Vital pulp therapy including partial pulpotomy (PP) or full pulpotomy (FP) is the treatment option recommended depending on the depth of irreversible changes in the coronal pulp.
- IV. Complete irreversible pulpitis (extending into the radicular pulp)
 - A persistent inflammatory condition involving both the coronal and radicular portions of the pulp with the pulp becoming incapable of healing
 - Pulpectomy is the treatment of choice in this condition.

SECTION 3: PRELIMINARY CONSIDERATIONS FOR MANAGEMENT OF DEEP/EXTREMELY DEEP CARIES

The model of caries management changed with the understanding that primarily *infected* part of caries needs to be removed, while the *affected* part can be left behind during cavity preparation.^[6,10,27] While scientifically sound, clinical demarcation between the two parts is difficult. This has led to the search for a more clinically relatable guide to the removal of caries. Color and hardness are often suggested as useful clinical guides to direct the extent of removal of caries.^[28,29] However, the alteration of the color of dentin is not limited to the demineralization activity. Both the active and arrested lesions may appear in shades ranging from light yellow to dark brown. With such variability, using color as a guide to removal is not advisable. Caries being a process involving loss of mineralized tissue later followed by

loss of organic matrix, hardness should be the primary indicator of the level of dentin involvement. From this point of view, the carious dentin present is divided soft, firm, and hard dentin.^[10]

The use of a rubber dam is mandatory during the management of extensive carious lesions.^[1] In addition to providing routine benefits of aseptic and clear field, and preventing contamination of restorative materials, it provides a distinct advantage in such cases. Avoiding pulpal exposure has been a primary concern while excavating deep caries. However, exposures do occur during such exercises, and rubber dam if applied before the procedure, helps prevent bacterial contamination of these sites of exposure, thus improving the overall prognosis of the tooth.

In addition, magnification using loupes or preferably surgical operating microscope aids in better assessment of tissues and microscopic exposures and may be considered during caries removal.^[1,3,14] Caries detector dyes are often used in practice. Since they have been found to be associated with more aggressive removal of caries, their use is not warranted when trying to manage caries without causing pulp exposure.^[29] The use of burs is less efficient in giving a tactile feedback and can lead to overcutting at the floor. Hence, when employing selective removal sharp excavators should be used to remove caries in the deepest portion.^[14] It is noteworthy to mention here that care should be taken to use only sterile burs during the excavation of deep caries.

SECTION 4: MANAGEMENT OF DEEP CARIES AVOIDING PULPAL EXPOSURE

For deep caries, reaching inner quarter of dentin, the close proximity of the lesion to the dental pulp becomes a major concern. Carious lesions which are indicated for restoration avoiding pulp exposure are:

- Advanced carious lesions approximating the pulp, but separated from it by a radiographically detectable layer of hard or firm dentin
- Having vital pulp with no history of symptoms indicative of irreversible pulpitis
- A restorable tooth, after extension of outer peripheral walls to hard dentin [Refer Section 8 - Table 1].
- Patient informed and willing for the procedure.

In such cases, therefore, avoiding pulpal exposure becomes a priority on which decision-making for treatment procedures must rest. The main guiding principles to be considered during the management of such lesions are as under:

- Inactivation of caries activity
- Preservation of dental tissue

- Maintenance of pulpal health: Avoid pulpal exposure as long as possible and minimize pulpal irritation
- Prevention of recontamination and leakage along restoration margin
- Prolong life of the tooth and restore its form, function, and esthetics.

How much caries must be excavated

Black, in his famous work, gave a definite order of steps to be followed during caries removal and stated: “Generally when the cavity has been cut to form, no carious dentine will remain.” Although he is credited with establishing the scientific principles of cavity preparation, many of which are valid even a century later today, the removal of entire caries when it is close to the pulp is now considered an overtreatment.^[1,3,6,10,27] This is because it poses an increased risk of pulp exposure, which is known to adversely affect the treatment prognosis. While Black’s recommendations were based on preliminary studies of his times on the microbiological nature of the disease, even he stated that “It may truly be said that, without the presence of the principal causes no decay could occur, and also that, without reasonably favorable conditions for their action, these causes would not produce decay.”^[30] Recent research has shown that the carious lesion is a micro-ecosystem where bacteria grow when the conditions are suitable but fail to thrive when the environment is rendered unfavorable.^[31-33] Using this new paradigm, the removal of entire pulpal caries is now deemed unnecessary. Studies have demonstrated a substantial reduction in cultivable flora and a change in color and consistency of the pulpal floor indicative of caries arrest.^[31,32] A recent Cochrane review has also concluded that partial caries removal had lower number of failures than nonselective removal in permanent teeth.^[34]

Sometimes, one may encounter a tooth with deep caries having a layer of radiopaque dentin between the lesion and the pulp, but with symptoms indicative of irreversible pulpitis. In such cases, nonselective approach must be utilized. If there is no pulp exposure after complete removal of caries, the tooth must be restored and watched for symptoms. If, on the other hand, carious exposure is encountered, the tooth should be managed using pulpotomy or root canal treatment (RCT) as per the clinical judgment [Refer Section 8, Table 1].

Caries removal stepwise (two visits) versus selective (one visit)?

To minimize the potential complications that may occur during the complete excavation of caries, two alternative approaches to selective removal of caries have been investigated, with favorable results. “Stepwise caries removal” is performed in two visits. In the first session, caries is removed selectively and restored. The patient is then recalled after a few months,

when the restoration is removed followed by the removal of remaining caries on the pulpal floor and permanent restoration. It is based on the premise that removal of gross caries in the first visit aids in slowing the caries progression, while allowing production of tertiary dentin, thus, making it easier to remove caries at the next session without risking exposure.^[35] Proponents of this technique argue that the second visit helps remove remaining caries, assesses pulp and dentin response, and allows follow-up^[36-39] (deep caries patients are generally high risk who need regular follow-ups). Finally, this technique may be useful for clinicians who have difficulty accepting the idea of leaving any caries behind. It has its share of limitations, though.

A second visit to the dentist makes patient compliance dependent and adds to the cost of treatment.^[40] However, since the tooth is restored temporarily at the first visit, loss of restoration during the interim period may lead to failure. Stepwise caries removal may also pose a higher risk of pulp exposure, especially at the second visit.^[41-43]

Studies conducted on stepwise removal led to an interesting observation at the time of re-entry: the bacteria in the caries left behind either turned dormant or died and the pulpal floor exhibited an appearance of arrested caries.^[31,32] This led to the development of an even more conservative approach of “selective caries removal” in which the tooth is permanently restored after soft caries removal in the first visit itself.^[29] Compared to stepwise technique, this one is more cost-effective, is less dependent on patient compliance, and ensures better tooth conservation as no re-entry is required.^[41,44] Some studies have, however, suggested that a gap may form at the floor when using adhesive restorations since the floor is still soft and may come apart due to polymerization concentration stresses.^[45] There are fewer studies available comparing the survival of teeth following the use of two techniques, but there is still no clear winner in terms of tooth survival in long-term.^[41-43,46,47] Since both techniques have a lower exposure risk than nonselective removal and there is insufficient evidence to recommend any one of the two former methods, either of the two partial caries removal techniques can be utilized when managing extensive caries depending on the clinical judgment of the operator.

Table 2 shows step by step procedure for Indirect Pulp Capping.

Key recommendations

- Pulp exposure must be avoided in teeth with advanced carious lesions separated from the pulp by a layer of

radiopaque dentin, and no signs indicative of irreversible pulpitis

- Consistency of carious dentin should be considered a more reliable guide, compared to color, during tooth preparation
- Isolation under rubber dams is mandatory in such cases
- Use of magnification is preferable and recommended
- Partial caries removal (one-step or stepwise) and lining with fast setting calcium hydroxide (Dycal)/calcium silicate cements must be used in such cases. The permanent restoration must be placed at the earliest to prevent leakage.

Future directions for the management of deep caries

The debate of selective caries removal (single-step) versus stepwise caries removal (two-step) is still not settled and needs to be explored. Good quality randomized controlled trials analyzing success as well as patient-centric outcomes are needed to provide evidence-based guidelines. The depth of caries, symptomatology, surfaces involved, and periodontal status of the included teeth must be clearly defined. Since research from academic institutions is performed under ideal conditions, studies from practice establishments will provide better evidence regarding its suitability in general practice. The use of hand instrumentation versus rotary instrumentation methodology for partial caries removal also needs investigation. Studies examining the effect of remaining carious dentin on pulpal response, and the count and composition of microflora will help strengthen the premise of leaving caries behind to avoid pulp exposure.

SECTION 5: MANAGEMENT OF EXPOSED PULP: CARIOUS PULP EXPOSURE

Existing knowledge and clinical recommendation

In recent years, there has been a paradigm shift in the management of teeth with exposed pulp, driven by an enhanced understanding of pulp pathophysiology. As a consequence, VPT now takes precedence in the hierarchy of treatment planning while managing carious exposure. When dealing with carious pulp exposure, two primary treatment options come into consideration: direct pulp capping (DPC) and pulpotomy (partial and full).

Carious exposures differ from traumatic exposure in terms of the degree of pulpal inflammation and the potential for infection spread. Therefore, it is necessary to adopt a stringent approach to managing carious exposures to ensure successful outcomes. Hence, an enhanced VPT protocol is recommended while managing carious exposure, incorporating the use of a hydraulic calcium silicate cement, an operating microscope, and/or the use of a disinfection

agent. This enhanced protocol has been associated with higher levels of success after nonselective (complete) caries removal, leading to pulp exposure.^[48,49]

Intraoperative findings, including dentine consistency and the condition of the exposed pulp, assume heightened importance in determining the true state of pulpal health while managing carious exposure. A thorough examination of the exposed pulp for any degenerative changes and precise recording of hemostasis time becomes imperative for establishing an accurate pulpal diagnosis. Only then should the relevant treatment modality be decided on, tailored to the specific needs of each individual case. It should be noted that teeth exhibiting signs and symptoms of complete irreversible pulpitis/pulp necrosis, radiographic signs of periapical rarefaction, negative responses to electric pulp and cold tests, positive responses to percussion or palpation, compromised periodontium and unrestorable crowns are not suitable candidates for VPT and should be managed with pulpectomy.

The subsequent text presents recommendations for effectively managing carious pulpal exposure, drawn from existing scientific evidence:

Direct pulp capping

DPC is considered the most conservative and simplest method for maintaining pulp vitality. It involves applying a biomaterial directly onto the exposed pulp before immediately placing a permanent restoration under aseptic conditions.

Indications for DPC include traumatic/iatrogenic pulp exposures < 1 mm in diameter through sterile dentin or pulp exposures during caries removal in deep or extremely deep carious teeth, provided there are clinical signs and symptoms of reversible pulpitis.

Classification: There are two distinct classes of DPC:^[1]

Class I DPC: Applicable when there is no preoperative evidence of a deep carious lesion, and the pulp exposure is clinically determined to be through sound dentin, with an expectation that the underlying pulp tissue remains healthy. This scenario often arises from a traumatic injury or iatrogenic exposure.

Class II DPC: Relevant when preoperative evidence points to a deep or extremely deep carious lesion, and the pulp exposure is deemed to be through a zone of bacterial contamination, with an expectation of underlying pulp tissue inflammation. Noteworthy to mention here, that

such cases will be candidates for DPC only when there are clinical signs and symptoms that are suggestive of reversible pulpitis.

Over the years, DPC has been the focus of numerous investigations. Earlier experiments, where bacterial contamination could not be adequately controlled, reported low success rates, leading to doubts about the clinical utility of the technique.^[50] However, recent studies have shown that using biocompatible materials with good sealing properties, such as mineral trioxide aggregate (MTA), Biodentine, and other calcium silicate cements, significantly increase the success rates of treating cariously and traumatically exposed teeth.^[48,49]

Prognostic factors for DPC include the site of exposure, patient age, the pulp capping material used, depth of caries, and preoperative diagnosis. Existing literature suggests that young patients (<40 years) and occlusal exposures have a more favorable prognosis compared to older patients (above 40 years) with axial exposures.^[51] Caries depth is an important factor in assessing the outcome of DPC. However, until now, studies have not been conducted based on the depth of caries, whether it is deep caries or extremely deep caries in radiographs.^[52] Future studies should consider this aspect to provide more comprehensive insights.

A systematic review by Cushley *et al.*,^[19] reveals that DPC is generally an effective treatment for teeth with deep caries and pathologically exposed pulps, particularly when the pulpal diagnosis is reversible pulpitis. Calcium silicate-based materials have shown better performance as pulp capping agents over a long period compared to calcium hydroxide, likely due to the weaker structural stability and sealing ability of calcium hydroxide. However, it is essential to note that this data comes from research with poor methodological quality and a significant potential for bias. Additional well-designed and appropriately powered randomized studies are necessary to confirm these results and address any uncertainties.

Table 3 provides step by step procedure for DPC.

Partial pulpotomy

PP is the removal of a small portion of coronal pulp tissue (2–3 mm of pulp tissue) at the site of pulp exposure, followed by the application of a biomaterial directly onto the remaining pulp tissue before placement of a permanent restoration. The indications are mature and immature permanent posterior teeth with deep/extremely deep carious lesion and a pulpal diagnosis of symptomatic partial irreversible pulpitis.

**TABLE 2: STEP BY STEP TREATMENT PROCEDURE CHART FOR
SELECTIVE CARIES EXCAVATION**

INDICATIONS

- Deep carious lesions (radiographically) approximating the pulp, separated from it by a radiographically detectable layer of hard or firm dentin (radio-dense dentin) .
- Patient reporting with No/mild symptoms, Responsive to pulp sensibility tests (Cold/EPT)
- A restorable tooth, after extension of outer peripheral walls to hard dentin.

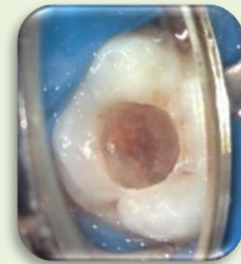


PROCEDURE

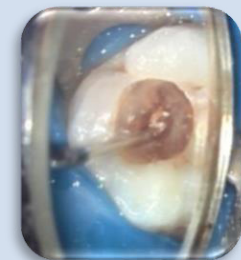
Administer local anaesthesia, preferably nerve block, and isolate the tooth under rubber dam



Remove all caries and undermined enamel from external walls using high speed 6-8 fluted carbide burs and hand excavators

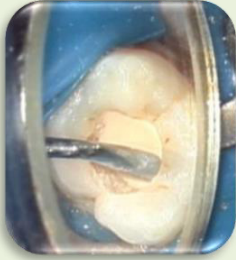





Remove the remaining soft caries left in pulpal direction using sharp hand excavators limiting it to the extent beyond which exposure is anticipated



PP has a higher chance of healing compared to DPC due to the removal of superficial inflamed pulp tissue.^[50,53,54] Moreover, PP is more conservative than FP, where the cell-rich coronal pulp is preserved, ensuring continuous deposition of cervical

dentin and reducing the risk of canal obliteration.^[55,56] In addition, because a significant amount of coronal pulp tissue remains after PP, the tooth exhibits more predictable healing and pulp sensibility responses.^[57]

<p>Use CSC to entirely cover the remaining caries (fast-setting CSCs preferred)</p> <p>If CSC with long setting time has been used, apply a small amount of light cured RMGIC to cover the cement and light cure according to manufacturer's instructions</p> <p style="text-align: center;">↓</p>		
<p>Apply self-etch bonding agent to the remaining cavity walls and cure following manufacturer's instructions.</p> <p>Restore the remaining cavity with resin composite material</p> <p style="text-align: center;">↓</p>		
<p>Take immediate postoperative radiograph for future reference</p> <p style="text-align: center;">↓</p>		
FOLLOW-UP OF CASES		
<p>Immediate follow up at 24hr, 48hr and 7 days to assess the post operative pain.</p> <p>Recall the patient 6 and 12 months postoperatively and at yearly intervals for 4 years thereafter</p>		
<p>Do the pulp sensibility tests and take radiographs in each follow-up visit</p>		
<p><u>SUCCESS OUTCOME PARAMETERS TO BE ASSESSED</u></p>		
PATIENT CENTRIC PARAMETERS	CLINICIAN CENTRIC PARAMETERS	
Absence of post-operative pain, swelling, sinus/	Presence of positive response to pulp sensibility tests and normal	

Elmsmari *et al.* reported an impressive 96% overall success rate for PP in cariously exposed permanent teeth.^[58] The patient's

age and root apex closure did not affect the outcome, with the only significant predictor being the preoperative pulp diagnosis.

fistula, pathologic mobility	peri-radicular architecture, absence of root resorption on the recall radiographs	
FAILURE		
Presence of spontaneous/lingering severe pain, tenderness to percussion, development of a sinus tract, swelling, a negative response to pulp sensibility tests or presence of intra-radicular/extra-radicular pathosis on the recall radiographs		
		<i>Images Courtesy: Maulana Azad Institute of Dental Sciences, New Delhi</i>

**In case stepwise approach is selected, the same procedure is recommended for caries removal as given above. Here, it is advisable to place a coloured glass ionomer over the remaining caries for easy identification at the second visit, followed by restoration with resin composite material. At the second visit after 6 months, the restoration as well as remaining caries are removed and the tooth is restored as described above in the flowchart.*

Cases with irreversible pulpitis showed a lower success rate, specifically 75% for symptomatic irreversible pulpitis (SIP) at 1 year. Conversely, presumed normal or reversible pulpitis cases had a higher success rate of 98% at 1 year.

Nevertheless, recent randomized clinical trials by Ramani *et al.*, Jassal *et al.*, and Baranwal *et al.* revealed comparable results for partial and FP in SIP cases, with success rates of 80.8%, 88%, and 80.7%, respectively.^[59-61] These findings indicate that PP can be a viable option for treating SIP, as long as hemostasis is achieved within 10 min after the procedure. However, further studies with long-term follow-up are required to strengthen this evidence.

Table 4 provides step by step procedure for PP.

Full pulpotomy

The FP procedure involves the complete removal of the coronal pulp, followed by the direct application of a biomaterial onto the pulp tissue at the level of the root canal orifice(s). FP finds its clinical indications in both mature and immature permanent posterior teeth presenting with deep/extremely deep occlusal or proximal carious lesions and a pulpal diagnosis of symptomatic partial irreversible pulpitis.

In a recent systematic review conducted by Cushley *et al.*, encouraging results were reported, indicating a clinical

success rate of 97.4% and a radiographic success rate of 95.4% for FP after a 1-year follow-up in cases of cariously exposed permanent teeth exhibiting signs indicative of SIP.^[18] Furthermore, recent randomized clinical trials have consistently demonstrated successful outcomes for FP, with success rates ranging from 89.8% to 92.8% in cases of SIP.^[52,59,60] Notably, a clinical trial by Taha, comparing RCT and FP, yielded comparable success rates, both reaching 93%.

Regarding patient satisfaction, a noteworthy finding emerged from comparative studies between FP and RCT. Patients reported higher levels of contentment with pulpotomy, particularly with regard to the amount of time involved, intraoperative pain, pleasantness, and expense.^[62]

Postoperative pain management after vital pulp therapy (VPT) demands careful attention. As part of the management approach, patients are advised to receive prescribed analgesics, particularly 400 mg of Ibuprofen, administered by the clock if required. In addition, it is important to note that an antibiotic regimen is not recommended after treatment.^[63-67]

Table 5 provides step by step procedure for FP.

TABLE 3: STEP BY STEP TREATMENT

PROCEDURE CHART FOR DIRECT PULP CAPPING

INDICATIONS

- Small Carious exposures, with mild symptoms and normal periapical tissues (Periapical index score ≤ 2)
- Traumatic/Mechanical exposure surrounded by sound dentin and when adequate hemostasis can be achieved
- A positive response to cold test and/or electric pulp test



PROCEDURAL STEPS

Rinse the oral cavity for 30 seconds with 0.2% chlorhexidine digluconate



Administer inferior alveolar nerve block/ appropriate nerve block. Wait for 15 minutes to ensure pulpal anaesthesia (no response to 2 consecutive EPT tests)



Apply rubber dam for tooth isolation

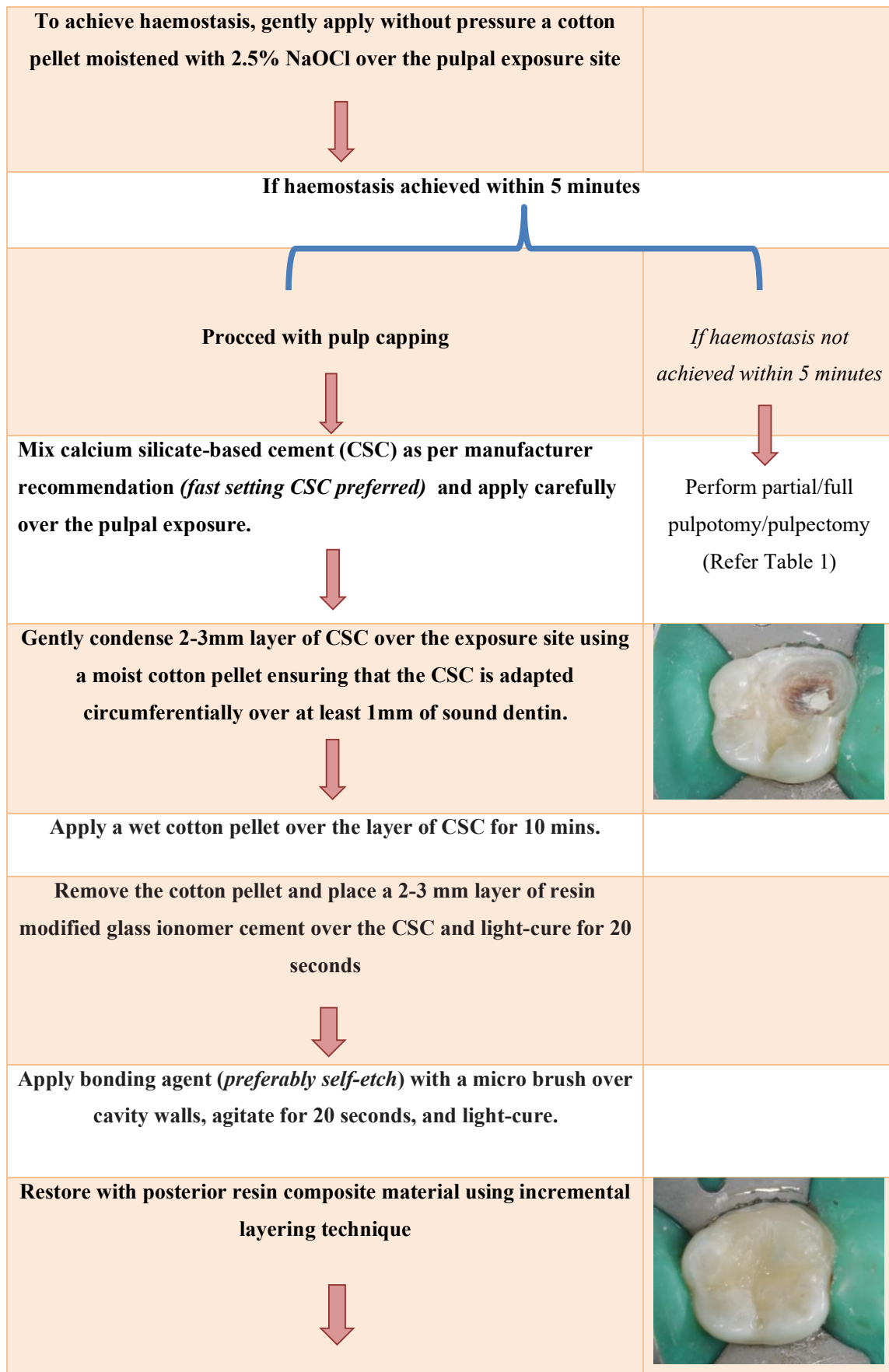


Remove all caries and undermined enamel from external walls using high speed 6-8 fluted carbide burs and hand excavators



Remove the remaining soft caries left in pulpal direction using sharp hand excavators, exposing the pulp






Remove the rubber dam			
↓			
Make the occlusal adjustments and finish the restoration using 16 fluted tungsten carbide bur and polish with rubber abrasive points			
↓			
Take immediate post-operative radiographs			
Prescribe analgesics (200-400mg ibuprofen) for the patients.			
<u>FOLLOW-UP OF CASES</u>			
Immediate follow up at 24hr, 48hr and 7 days to assess the post operative pain.			
Recall the patient 6 and 12 months postoperatively and at yearly intervals for 4 years thereafter			
Do the pulp sensibility tests and take radiographs in each follow-up visit			
SUCCESS OUTCOME PARAMETERS TO BE ASSESSED			
PATIENT CENTRIC PARAMETERS	CLINICIAN CENTRIC PARAMETERS		
Absence of post-operative pain, swelling, sinus/ fistula, pathologic mobility	Presence of positive response to pulp sensibility tests and normal peri-radicular architecture, absence of root resorption on the recall radiographs		
FAILURE			
Presence of spontaneous/lingering severe pain, tenderness to percussion, development of a sinus tract, swelling, a negative response to pulp sensibility tests or presence of intra-radicular/extra-radicular pathosis on the recall radiographs			
Images Courtesy: Centre for Dental Education & Research, AIIMS, New Delhi			

TABLE 4: STEP BY STEP TREATMENT PROCEDURE
CHART FOR PARTIAL PULPOTOMY

INDICATIONS

- Extremely deep Carious exposures, with mild/severe symptoms and normal periapical tissues (Periapical index score ≤ 2)
- A positive response to cold test and/or electric pulp test



PROCEDURAL STEPS

Rinse the oral cavity for 30 seconds with 0.2% chlorhexidine digluconate



Administer inferior alveolar nerve block/ appropriate nerve block. Wait for 15 minutes to ensure pulpal anaesthesia (no response to 2 consecutive EPT tests)



Apply rubber dam for tooth isolation

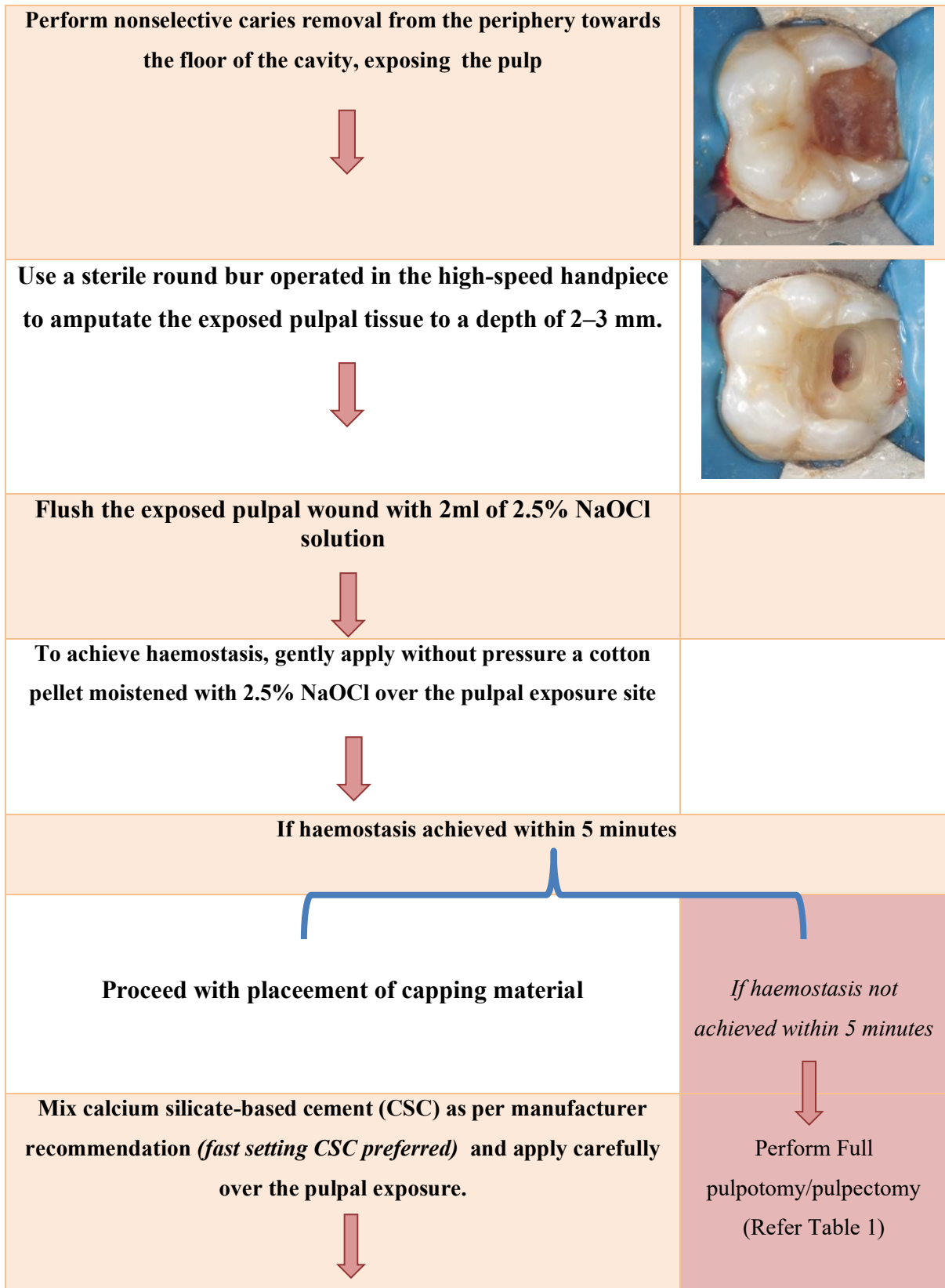


Before caries excavation disinfect the tooth with 5.25% NaOCl



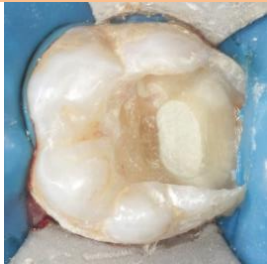



Remove all caries and undermined enamel from external walls using high speed 6-8 fluted carbide burs and hand excavators






Key recommendations

- Appropriate diagnosis and case selection are imperative for the success of the VPT procedures
- Isolation under a rubber dam is mandatory and the use of magnification (loupes/microscopes) is preferable
- 2.5% NaOCl should be used for disinfection and to arrest

<p>Gently condense 2-3mm layer of CSC over the exposure site using a moist cotton pellet ensuring that the CSC is adapted circumferentially over at least 1mm of sound dentin.</p> <p style="text-align: center;">↓</p>	
<p>Apply a wet cotton pellet over the layer of CSC for 10 mins.</p>	
<p>Remove the cotton pellet and place a 2-3 mm layer of resin modified glass ionomer cement over the CSC and light-cure for 20 seconds</p> <p style="text-align: center;">↓</p>	
<p>Apply bonding agent (<i>preferably self-etch</i>) with a micro brush over cavity walls, agitate for 20 seconds, and light-cure.</p>	
<p>Restore with posterior resin composite material using incremental layering technique</p> <p style="text-align: center;">↓</p>	
<p>Remove the rubber dam</p> <p style="text-align: center;">↓</p>	
<p>Make the occlusal adjustments and finish the restoration using 16 fluted tungsten carbide bur and polish with rubber abrasive points</p> <p style="text-align: center;">↓</p>	
<p>Take immediate post operative radiographs</p>	
<p>Prescribe analgesics (200-400mg ibuprofen) for the patients.</p> <p style="text-align: center;">↓</p>	

<u>FOLLOW-UP OF CASES</u>		
Immediate follow up at 24hr, 48hr and 7 days to assess the post operative pain. Recall the patient 6 and 12 months postoperatively and at yearly intervals for 4 years thereafter		
Do the pulp sensibility tests and take radiographs in each follow-up visit		
SUCCESS OUTCOME PARAMETERS TO BE ASSESSED		
PATIENT CENTRIC PARAMETERS	CLINICIAN CENTRIC PARAMETERS	
Absence of post-operative pain, swelling, sinus/ fistula, pathologic mobility	Presence of positive response to pulp sensibility tests and normal peri-radicular architecture, absence of root resorption on the recall radiographs	
FAILURE		
Persistent severe spontaneous pain, tenderness to percussion, development of a sinus tract, swelling, or a negative response to cold testing; and presence of intra-radicular or extra-radicular pathosis on the recall radiographs		
Images Courtesy: Centre for Dental Education & Research, AIIMS, New Delhi		

the bleeding

- Control of bleeding is the measure of the level of inflammation and hemostasis should be achieved within 5–10 min after performing VPT procedures
- Calcium silicate-based cement such as MTA or Biodentine are preferred as pulp capping agents
- Appropriate permanent restoration (direct/indirect) should be placed following a proper assessment of the

remaining tooth structure. This should be done as early as possible (preferably same visit) for the success of VPT.

Future directions

The management of carious pulp exposure continues to evolve, and future directions should focus on improving diagnostic accuracy, developing better materials, and conducting high-quality clinical trials to validate existing promising

TABLE 5 : STEP BY STEP TREATMENT PROCEDURE CHART FOR FULL PULPOTOMY

INDICATIONS

- Deep/Extremely deep Carious exposures, with Severe symptoms and normal periapical tissues (Periapical index score ≤ 2)
- A positive response to cold test and/or electric pulp test



PROCEDURAL STEPS

Rinse the oral cavity for 30 seconds with 0.2% chlorhexidine digluconate



Administer inferior alveolar nerve block/ appropriate nerve block. Wait for 15 minutes to ensure pulpal anaesthesia (no response to 2 consecutive EPT tests)

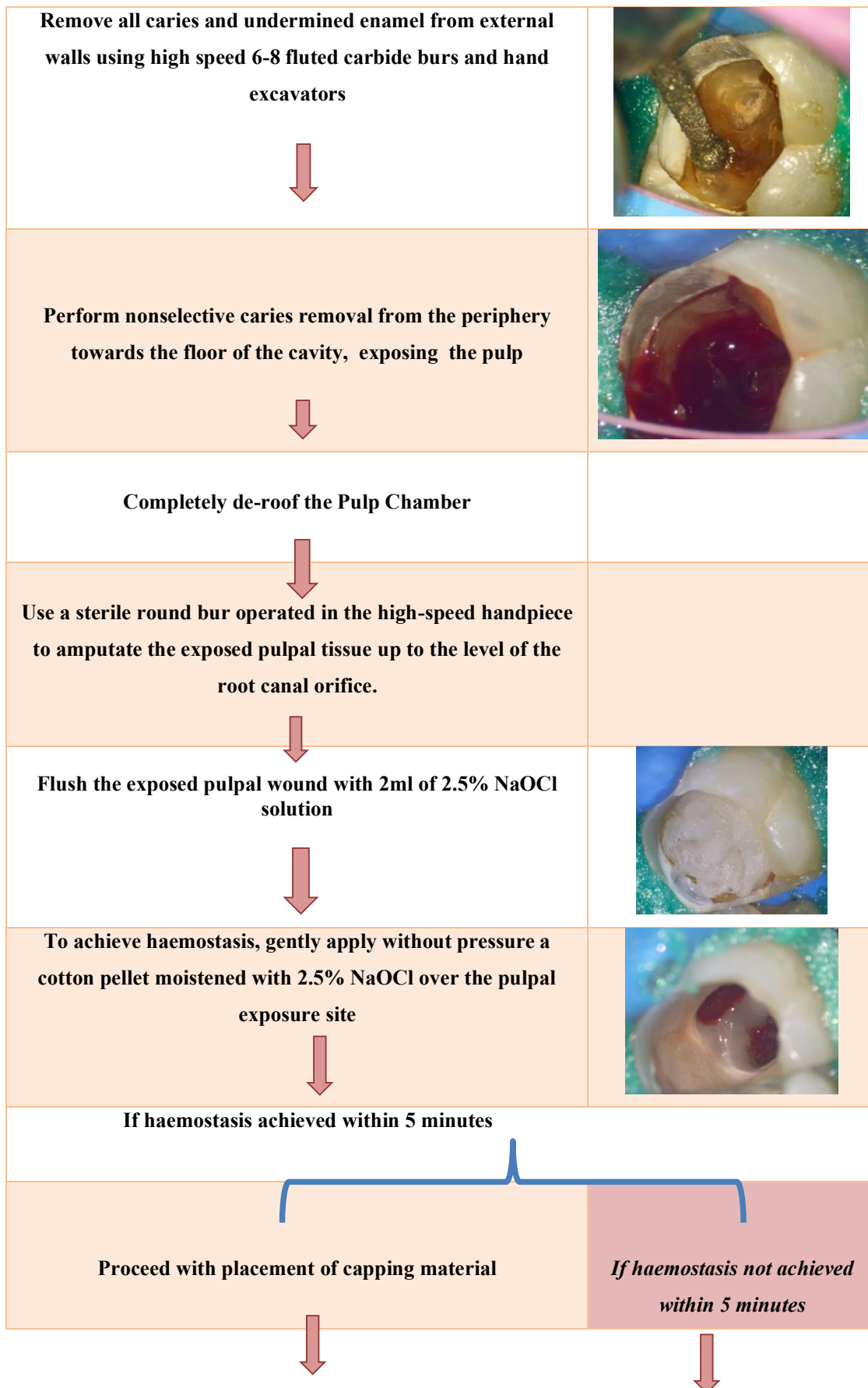


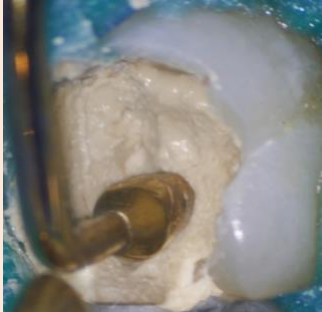
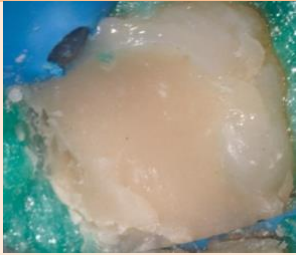
Apply rubber dam for tooth isolation

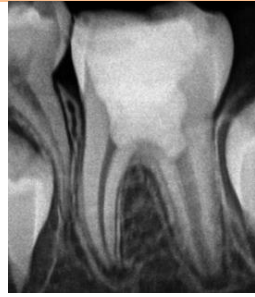



Before caries excavation disinfect the tooth with 5.25% NaOCl





<p>Mix calcium silicate-based cement (CSC) as per manufacturer recommendation (<i>fast setting CSC preferred</i>) and apply carefully over the pulpal exposure.</p> <p style="text-align: center;">↓</p>	<p>Perform Pulpectomy under rubber dam (Refer Table 1)</p>
<p>Gently condense 2-3mm layer of CSC over the exposure site using a moist cotton pellet ensuring that the CSC is adapted circumferentially over at least 1mm of sound dentin.</p> <p style="text-align: center;">↓</p>	
<p>Apply a wet cotton pellet over the layer of CSC for 10 mins.</p>	
<p>Remove the cotton pellet and place a 2-3 mm layer of resin modified glass ionomer cement over the CSC and light-cure for 20 seconds</p> <p style="text-align: center;">↓</p>	
<p>Apply bonding agent (<i>preferably self-etch</i>) with a micro brush over cavity walls, agitate for 20 seconds, and light-cure.</p>	
<p>Restore with posterior resin composite material using incremental layering technique</p> <p style="text-align: center;">↓</p>	
<p>Remove the rubber dam</p> <p style="text-align: center;">↓</p>	
<p>Make the occlusal adjustments and finish the restoration using 16 fluted tungsten carbide bur and polish with rubber abrasive points</p> <p style="text-align: center;">↓</p>	
<p>Take immediate post-operative radiographs</p>	

Prescribe analgesics (200-400mg ibuprofen) for the patients.		
<u>FOLLOW-UP OF CASES</u>		
<p>Immediate follow up at 24hr, 48hr and 7 days to assess the post operative pain.</p> <p>Recall the patient 6 and 12 months postoperatively and at yearly intervals for 4 years thereafter</p>		
Do the pulp sensibility tests and take radiographs in each follow-up visit		
SUCCESS OUTCOME PARAMETERS TO BE ASSESSED		
PATIENT CENTRIC PARAMETERS	CLINICIAN CENTRIC PARAMETERS	
Absence of post-operative pain, swelling, sinus/ fistula, pathologic mobility	Presence of positive response to pulp sensibility tests and normal peri-radicular architecture, absence of root resorption on the recall radiographs	
FAILURE		
Persistent severe spontaneous pain, tenderness to percussion, development of a sinus tract, swelling, or a negative response to cold testing; and presence of intra-radicular or extra-radicular pathosis on the recall radiographs		
<i>Images Courtesy: Root Canal Foundation, Chennai</i>		

techniques. Advancements in intraoperative diagnostic tools based on inflammatory biomarkers can significantly enhance the success of vital pulp therapy procedures. Moreover,

further research on biocompatible materials, such as calcium silicate-based cement, and the use of operating microscopes and disinfection agents should be encouraged to optimize

treatment outcomes. The development of targeting pulp capping materials which is based on biologic processes can increase the success of VPT. Proper operator training and experience should also be emphasized to ensure the success of vital pulp therapy in primary care settings. Updating the undergraduate and postgraduate curriculum and continuing dental education programs and training for general dentist can improve the success of VPT.

Currently, not enough data are available to study final restoration as a prognostic factor, so future researches can be conducted in this direction.

SECTION 6: FOLLOW UP OF CASES (WHAT TO EXPECT) AND PROGNOSIS ASSESSMENT

To ensure the long-term success and effectiveness of vital pulp therapy (VPT), comprehensive follow-up evaluations are essential. The outcome assessment should consider both clinician-centric and patient-centric measures to obtain a comprehensive understanding of the treatment's success.^[68,69]

Modern evidence-based practices lay primary emphasis on the patient's experience throughout the treatment process.^[70-72] The definition of success in endodontics has also evolved over time, with a growing focus on achieving long-term functional efficacy, and the tooth's ability to maintain its function in the arch over time, free from any signs of pathology or radiographic abnormalities.^[73,74]

Outcome assessment parameters

The clinician-centric measures of success include the absence of tenderness to percussion and palpation, normal response to pulp sensibility tests, absence of radiographic evidence of radiolucency or resorption, and the presence of radiographic evidence of hard tissue bridge formation or continuation of root development. The patient-centric outcomes include tooth survival, absence of pain, swelling, foul taste, or sinus tract, absence of adverse effects, integrity of the restoration, absence of the need for medication or further intervention, feeling of well-being, the cost-effectiveness of the treatment, and quality of life. It is important to note that some outcome measures may have both clinician-centric and patient-centric components and any failure in any part of the composite will equate to overall treatment failure.

As the primary goal of VPT is to preserve pulp vitality, response to pulp sensibility tests and radiographic evidence of emerging radiolucency are the most important clinician-reported outcome measures. Whereas from a patient's perspective, the most relevant parameters include

tooth survival, tooth function, presence of pain or tenderness, swelling, and the need for medication.^[71]

At present, intraoral periapical radiograph at 1 year is recommended for the evaluation of periapical tissues. However, in recent years, cone-beam computed tomography (CBCT) has gained widespread acceptance and can be beneficial in assessing the outcomes of VPT in cases with complicated anatomy or treatment outcomes that are difficult to evaluate using conventional radiography. However, CBCT should be reserved for cases where conventional radiography is inadequate and should not be employed as a routine imaging modality for outcome assessment.^[75,76]

Importance of evaluation of coronal restoration

Vital pulp therapy failures are mostly of two types: early failure and late failure. Early failure occurs due to the inaccurate diagnosis of the inflammatory status. While late/delayed failures mainly occur due to bacterial leakage from the fractured/improper coronal restoration. Hence, proper preoperative restorative assessment and follow-up is of paramount importance for long-term survivability/functionality of teeth after VPT Procedures.^[77] After the placement of pulp capping material teeth should be restored with permanent restoration either with a direct composite restoration or indirect onlay restoration based on the assessment of the remaining tooth structure.

On follow-up, restorative status evaluation involves the assessment of the integrity, stability, and longevity of the restorations placed after the completion of VPT.^[78] Criteria for evaluation include occlusion, marginal integrity, esthetics, sensitivity, and functional performance. Standardized dental indices like the USPHS and Modified Ryge Criteria can be employed to ensure consistent assessments and comparisons.^[79-81] Utilizing standardized indices to document the restorative status during follow-up visits after VPT can enhance the objectivity and reliability of the evaluation process.

Follow up time

The appropriate timing for follow-up after vital pulp treatment depends on the specific outcome being measured. Although there is significant variation in the literature regarding the ideal follow-up time, it is generally accepted that to evaluate the long-term effectiveness of VPT in treating pulpitis and apical periodontitis or tooth survival, follow-up should continue for as long as possible, with a minimum of 1 year. Follow-up evaluations should be performed at regular intervals, with the first appointment scheduled within 1–3 months of the initial treatment, and subsequent appointments scheduled at 6, 12, and 24 months, and then annually thereafter. When evaluating outcome measures related to acute symptoms, such as pain or swelling, follow-up should be conducted within a shorter timeframe, such as 24 h, 48 h, and 1 week–3 months.^[71]

SECTION 7: SUMMARY OF KEY RECOMMENDATIONS

Position statement	Recommendations
Steps to diagnosing pulpal inflammation level	Provisional diagnosis of extent of caries and the pulpal status for VPT procedures, should be based on preoperative symptoms of patient (subjective, objective) Radiographic depth of lesion, and intra-operative assessment. Caries excavation should be considered a diagnostic procedure prior to final diagnosis of pulpal disease
Classifying pulpal disease severity	As our concepts for vital pulp therapy have evolved, "Irreversibility" of pulpal disease is questioned. Only the irreversibly damaged part of the pulp as determined by the intra-operative examination, is recommended to be removed. On the basis of above diagnostic steps, the pulpal inflammatory status may be classified as; normal pulp, reversible pulpitis, partial irreversible pulpitis (restricted to the coronal pulp), complete irreversible pulpitis (extending into the radicular pulp)
Use of effective isolation during management	Use of rubber dam and prevention of salivary contamination is mandatory for performing any kind of vital pulp therapy procedure for management of deep/extremely deep caries Pulpal exposure that occurs in absence of rubber dam and has salivary contamination should be treated with pulpectomy
Deep (radiographic depth) caries management	Radiographic depth should be co-related with patient symptoms For patients with which are asymptomatic or mild symptoms, it may be managed by selective excavation - one stage/stepwise (as per clinician's choice) Deep caries with severe symptoms should be managed by nonselective excavation and carious exposure should be managed as below Consistency of deepest layer of dentin (soft/firm/hard) should be the primary indicator of the level of dentin involvement
Extremely deep (radiographic depth) caries management	For lesions extending into inner third of dentin, nonselective excavation should be done Iatrogenic exposures/small carious exposure (s) occurring under sterile conditions, which are asymptomatic or mild symptomatic cases, may be managed using direct pulp capping if hemostasis of exposed pulp is achieved within 5–10 min Carious exposures with severe symptoms, may be treated with partial pulpotomy, provided pulpal hemostasis is achieved within 5–10 min and visual examination reveals healthy pulp tissue. This may be indicative of partial irreversible pulpitis, limited to coronal pulp If hemostasis was not achieved within 5–10 min after the partial pulpotomy, full pulpotomy may be performed Pulpectomy will be the treatment of choice teeth in which hemostasis could not be achieved within 5–10 min after carrying out full pulpotomy Usage of magnification (loupes/microscope) and illumination tools at this stage are key to making the right diagnosis and thereby appropriate treatment choice
Pulp capping materials	Calcium hydroxide (Dycal)/CSC, preferably with faster setting time is material of choice to be placed on deep dentin. Calcium silicate based cement would be the preferred material to be placed in contact with exposed pulp as capping material/ for pulpotomy. In case a longer setting capping material is used, apply a layer of resin modified glass ionomer cement to cover the cement

Restorative evaluation	Primary cause of late/delayed failures of VPT have been due to bacterial leakage from the fractured/improper coronal restoration. Proper preoperative restorative assessment, followed by appropriate direct/indirect restoration which is assessed on regular intervals is of paramount importance for long term survivability/ functionality of teeth following VPT procedures
Follow-up and outcome assessment	Posttreatment, patient should be kept on regular follow-up. Immediate follow up can be done at 24 h, 48 h and 7 days to assess the postoperative pain Recall the patient 6 and 12 months postoperatively and at yearly intervals for 4 years there-after. A thorough history taking, clinical examination, integrity of permanent restoration, pulp sensibility testing (direct pulp capping and partial pulpotomy) and radiographs should be done at each follow-up visit Success may be determined by assessing patient, and clinician centric outcome variables

VPT: Vital Pulp Therapy, CSC: Calcium silicate-based cement

SECTION 8: DECISION-MAKING CHART

This section deals with the decision making flowchart of deep carious lesions [Table 1].

SECTION 9: STEP BY STEP TREATMENT PROTOCOLS [TABLES 2-5]

This section details the step by step treatment protocols for clinical conditions with deep carious lesion [Tables 2-5].

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Conflicts of interest

There are no conflicts of interest.

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