

# Management of iatrogenic root perforation with grade II furcation involvement through guided tissue regeneration technique: A case with comprehensive review of clinical literature

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## Abstract

The aim of this case report was to describe a successful repair of a long-standing furcal and coronal root perforation with grade II furcation involvement in the mesiolingual canal of a lower first molar. A 41-year-old male patient reported with the chief complaint of mild intermittent pain and pus discharge from mandibular left first molar for 1 year. Upon clinical and radiographic examination, a pulpal diagnosis of previously initiated therapy with root perforation was made. In addition, the tooth had a periapical diagnosis of chronic apical abscess, as well as a primary endodontic and secondary periodontal lesion with grade II furcation involvement. Root canal treatment and surgical repair of the perforation and furcation involvement with Mineral Trioxide Aggregate and bone graft was done. Recall examination after 2 years showed no evidence of periodontal breakdown. The patient was asymptomatic, and favorable bone regeneration and periodontal healing were seen on the radiograph. A literature review was also conducted to assess the factors affecting the prognosis of perforation repair in molars. Long-standing cervical root and furcal perforations readily lead to persistent endo-perio lesions and have been found to have the worst prognosis. A biocompatible sealing of the perforation site along with periodontal regeneration effectively enhances the longevity of such teeth. Though there are very few case reports that advocated the use of guided tissue regeneration for periodontal regeneration, nevertheless it has proven to be a reliable technique to improve the prognosis for crestal level and furcal root perforations.

**Keywords:** Endo-perio lesion, furcation perforation, guided tissue regeneration, root perforation, surgical perforation repair

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## INTRODUCTION

Endodontic procedural errors jeopardize the outcome of root canal treatment. Perforation, among them, is one of the most common causes of endodontic treatment failure accounting for nearly 10% of all failed cases.<sup>[1]</sup> Perforation can be defined as pathological or mechanical communication between the root canal system and the periradicular tissues/oral cavity. Its etiology could be pathologic (deep carious lesion, root resorption), restorative (during post space preparation), or iatrogenic (during access cavity preparation and root canal instrumentation).<sup>[2]</sup>

Iatrogenic perforations often ensue due to a lack of knowledge or attention to the morphologic and anatomic details of crown and root canal system and their variations. The frequency of iatrogenic root perforation in endodontically treated teeth ranges from 2% to 12%.<sup>[3]</sup> According to Kvinnsland *et al.*,<sup>[4]</sup> of all iatrogenic root perforations, 53% occurred during postplacement, while 47% occurred during root canal therapy, and maxillary teeth (73%) were affected more frequently than mandibular teeth (23%). Whereas, Tsesis *et al.*<sup>[5]</sup> recorded 55% of perforations in lower molar teeth.

Perforation causes injury to the periodontium, inciting inflammation, bacterial infection, alveolar bone destruction, formation of granulomatous tissue, epithelial proliferation, and eventually, the development of a periodontal pocket.<sup>[6]</sup> Fuss and Trope<sup>[2]</sup> defined the level of crestal bone and epithelial attachment as “critical zone” as perforations at this level are vulnerable to microbial contamination, periodontal breakdown, and epithelial migration. The furcation area of multi-rooted teeth has also been considered as a critical zone due to its proximity to the biological width. Furcal perforations readily lead to furcal bone loss and persistent endo led perio lesion. Such defects are challenging to treat because of the anatomic and topographic complexity that impairs proper debridement.<sup>[7]</sup> Delay in perception and treatment of perforation can cause further complications leading to tooth loss. Thus, perforation needs to be diagnosed early and treated appropriately. It has been well known that a good prognosis is associated with small perforation, located at coronal or apical to crestal level and after immediate sealing with biocompatible material.<sup>[2]</sup>

Various materials (amalgam, gutta-percha, calcium hydroxide, Super Ethoxy-benzoic acid, intermediate restorative material, Glass ionomer cement, Resin composite) have been used in the past for perforation repair. However, none could successfully re-establish

the normal periodontal attachment in perforated furcation.<sup>[8]</sup> Tri-calcium silicate-based cement Mineral Trioxide Aggregate (MTA) has been considered as the material of choice for such repairs with enhanced success rate<sup>[9]</sup> because of its good sealing ability, biocompatibility, osteogenic and cementogenic potential,<sup>[10]</sup> and ability to set in the presence of blood.<sup>[11]</sup> Despite its widespread use, MTA has certain drawbacks such as poor handling, extended setting time, and high cost which have paved the way for other calcium-silicate biomaterials such as Biodentine and Calcium Enriched Mixture (CEM).

A perforation can be repaired with non-surgical or surgical approach. However, a significant problem with the non-surgical repair is the extrusion of filling material into the periodontal space, which interferes with the periodontal re-attachment.<sup>[12]</sup> Surgical method has the added advantage of bone grafts, platelet-rich fibrin (PRF), and guided tissue regeneration (GTR) to ensure rapid and predictable healing.<sup>[13]</sup> Attempts to seal long-standing perforation with MTA, together with bone and periodontal regeneration, enhances healing and improves the overall outcome.<sup>[11]</sup> The use of barrier membranes in endodontic surgery was first advocated by Duggins *et al.*<sup>[14]</sup> for the management of root perforation.

There is a need for evidence-based data that would be valuable for decision-making and treatment planning for perforation cases. There is still a lack of studies with larger clinical data and human control trials that evaluate the effect of preoperative factors on the outcome of clinical procedures. Therefore, this paper aims to (a) report a case of long-standing iatrogenic furcal and coronal root perforation repaired with MTA, and surgical management of the associated endo-perio lesion with grade II furcation defect via GTR technique; (b) critically review the literature of existing case reports of perforation repair and to evaluate the factors affecting treatment outcome.

## CASE REPORT

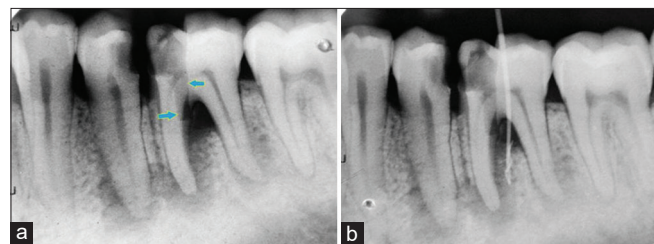
A 41-year-old male patient reported to the Department of Conservative Dentistry and Endodontics with the chief complaint of mild intermittent pain and pus discharge from the lower left back teeth for 1 year. The patient had a noncontributory medical history. Past dental history revealed an unsuccessful attempt of root canal treatment performed on mandibular first molar (#36), 7 months back by a general dental practitioner. Clinical examination revealed that mandibular second premolar (#35) and #36 were non-vital and were tender on percussion. Tooth #35 was cariously exposed, and tooth #36 had an access

opening done. A deep pocket of 7 mm with a sinus tract opening buccally in relation to tooth #36 was also present.

Radiographic examination revealed periapical radiolucency present in relation to both teeth (#35 and #36). It was apparent from the radiograph that tooth #36 had an iatrogenic perforation in the mesial root, communicating to the furcation [Figure 1a]. In addition, tooth #36 had a J-shape radiolucency along the distal aspect of the mesial root, extending from the furcation to the periapex. Gutta-percha tracing of the sinus tract was directed along this radiolucency beside the mesial root [Figure 1b]. There was grade II bone loss at the furcation, as there was no gingival recession. A pulpal diagnosis of previously initiated therapy of tooth #36 with procedural errors of root perforation was made. A periapical diagnosis of chronic apical abscess #36 was also made. Periodontal diagnosis included primary endodontic and secondary periodontal lesion along with grade II furcation involvement. Tooth #35 had a diagnosis of pulp necrosis with asymptomatic apical periodontitis.

The treatment options were discussed with the patient. Nonsurgical root canal treatment was planned for #35. Treatment options for #36 included root canal treatment and surgical repair of perforation with periodontal regenerative therapy, hemisection of the mesial root, or extraction. The patient expressed the desire to retain the tooth and opted for root canal treatment and surgical perforation repair.

Treatment was carried out in multiple visits. For tooth #36, access opening was refined under rubber dam isolation and the floor and orifices, as well as the perforation site, were clearly inspected. Three canals Mesio Buccal (MB), Mesio lingual (ML), and distal, were located and filed with a #10 K file (Dentsply Maillefer, Ballaigues, Switzerland). The perforation was found to be situated buccal to the ML orifice, as was confirmed by periapical radiograph, periodontal probe and apex locator (ProPex; Dentsply Maillefer, Ballaigues, Switzerland) [Figure 2a]. The



**Figure 1:** Preoperative radiograph of left mandibular first molar showing a tubular shape perforation (arrow marks) and furcal bone loss (a). Radiograph showing sinus tract tracing with gutta-percha (b)

perforation was tubular with a diameter of 2 mm and length of 5 mm. It originated immediately buccal to the orifice of the ML canal at the pulp chamber floor and involved the coronal third of the root encroachment of the furcation. Irrigation was done with 1% sodium hypochlorite and large volumes of normal saline to flush the site of perforation. After establishing working length, the ML canal was prepared up to Protaper universal finishing file F1 (Dentsply Maillefer, Ballaigues, Switzerland) while irrigating with 2% chlorhexidine (Septodont, Saint-Maur-des-Fossés, France) and normal saline. Then a small plug of cotton and hard setting calcium hydroxide was placed over the ML orifice to block the perforation site to complete the biomechanical preparation for MB and D canals. Irrigation was done with 2.5% sodium hypochlorite (Septodont, Saint-Maur-des-Fossés, France). Access opening and biomechanical preparation were completed in #45 using Protaper universal files (Dentsply Maillefer, Ballaigues, Switzerland) up to file F3 in a crown-down technique and copious irrigation with 2.5% sodium hypochlorite. Calcium hydroxide dressing (Metapex, Meta Biomed, Korea) was placed in the root canal of tooth #35 and all the canals of tooth #36. The teeth were temporarily restored with Cavit (3M ESPE, Minnesota, USA).

After 2 weeks, obturation was done in tooth #45 and in the distal and MB canals of tooth #46 with gutta-percha (Dentsply Maillefer, Ballaigues, Switzerland) and AH plus sealer (DeTrey/Dentsply, Konstanz, Germany) using lateral condensation technique and temporary restoration was placed.

After 1 week, surgical repair of the perforation and furcation area were scheduled. In the subsequent visit, surgery was performed under local anesthesia. Inferior alveolar nerve block and buccal nerve block was given using 2% lidocaine hydrochloride with adrenaline (1:80,000). A horizontal incision was made from the mesial line angle of tooth #35 to the distal line angle of tooth #37, along with a vertical incision. A full-thickness mucoperiosteal flap was reflected. Complete debridement with normal saline and curettage of granulation tissue in the furcation area was achieved [Figure 2b]. A sterile gauge was placed into the interradiolar area. Perforation repair was commenced with MTA after fitting the master cone gutta-percha F1 in the ML canal to prevent filling of the canal with repair material. MTA Angelus (Angelus, Londrina, Brazil) was mixed in a 3:1 ratio according to the manufacturer's instructions. Micro apical placement system (Dentsply Maillefer, Ballaigues, Switzerland) was used to lightly condense the MTA from the floor of the pulp chamber up to the furcation. Any extruded MTA was removed, and

burnishing was done at the root surface. The furcation area was filled with hydroxyapatite bone graft Sybograf® (Eucare pharmaceuticals, Chennai, India) then resorbable collagen membrane Periocol® (Eucare pharmaceuticals, Chennai, India) was covered over the bone defect such that its margins were well within the lines of incision and supported by the remaining cortical bone [Figure 2c]. The flap was repositioned and stabilized by sutures. A wet cotton pellet was placed in the pulp chamber, and the access opening was sealed with temporary dressing.

After 24 h, the hardness of set MTA was assessed, the ML canal's obturation was completed, and permanent restoration was placed [Figure 2d]. Sutures were removed after 7 days. The patient was advised of periodontal maintenance, with regular flossing, brushing, and use of 0.2% chlorhexidine mouthwash for 30 days.

The patient was followed up after 1 month, 3 months, 6 months, 12 months, and 24 months. The tooth was asymptomatic at all the visits. On clinical examination, the patient had no pain, and the tooth was not tender on percussion. Follow-up at 12 and 24 months revealed no symptoms and reduction of the furcation and periradicular radiolucency [Figure 3a and b]. Furcal periodontium had regenerated and no pocket was probed [Figure 3c].

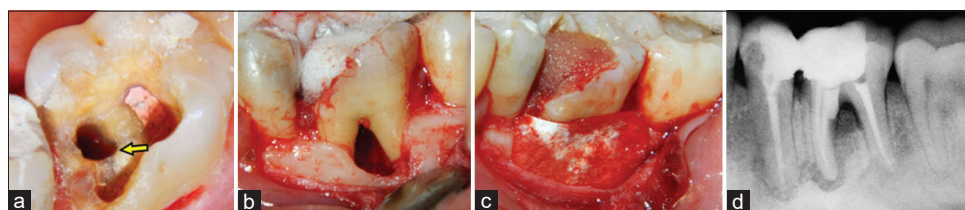
### LITERATURE SEARCH STRATEGY

A structured literature review was conducted for articles published between January 1970 and August 2020. The Internet databases PubMed, Scopus, and Web of Science

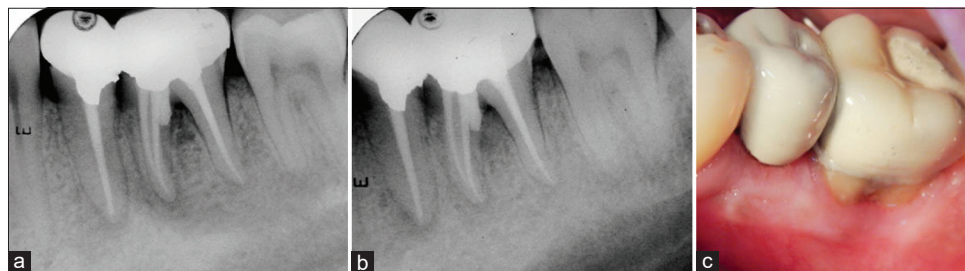
were used to search for the keywords “Furcation” OR “Root” OR “Strip” AND “Perforation” AND “Molar” AND “endo-perio lesions” OR “Perforation repair” AND “Guided Tissue Regeneration” OR “Guided Tissue Regeneration.” Only case reports of perforation in the maxillary and mandibular molars and written in the English language were included. Case reports of perforation in the maxillary and mandibular anterior and premolar teeth were excluded. Following the selection of articles for inclusion in this review, the references of those papers were manually searched and cross citations were detected. Finally, a total of 39 case reports presenting 62 cases of molar perforations were selected.

### DISCUSSION

Most of the existing literature on perforation is either retrospective studies with small sample size or case reports/series,<sup>[15]</sup> and only one retrospective case-control<sup>[5]</sup> and one prospective randomized clinical trial was found.<sup>[16]</sup> Furthermore, there are limited literature reviews that evaluated the risk factors related to root perforations. Since intentionally created perforation to conduct Randomized clinical trials on human subjects is unethical, in such scenario, case reports/series and their critical review are helpful for the diverse in-depth understanding of perforation and its etiology, evaluation methods, treatment strategies, and reasons for failure. This report has compiled the data of perforation repair of 62 molar teeth from 39 case reports which were published between 1979 and 2020. For the ease of understanding of the reviewed



**Figure 2:** Clinical photograph showing perforation location (arrow mark) at buccal surface of mesiolingual canal (a). Photograph after debridement and curettage of granulation tissue in furcation area (b). Photograph showing furcation defect and bone graft covered by guided tissue regeneration membrane (c). 24 h postoperative radiograph (d)



**Figure 3:** 12-months follow-up radiograph (a). 24-months follow up radiograph showing reduction of the furcation and periradicular radiolucency (b). Clinical photograph after 24-months follow-up (c)

literature we have categorized the perforation into four types according to their level and location:

1. Floor/furcal perforation
2. Coronal root perforation
3. Mid root perforation
4. Apical root perforation.

It should be noted that all of these perforations may extend into or away from the furcation/interradicular area.

Perforations are considered severe complications and pose a variety of diagnostic and management problems. Several preoperative and patient-related factors have been reported that may influence the outcome of perforation repair.<sup>[17,18]</sup> For instance, repairing an easily accessible and small perforation can be a simple task with good clinical success, but the treatment becomes more difficult with a poor prognosis when the perforation size is large and inaccessible. Siew *et al.*<sup>[18]</sup> did a meta-analysis and evaluated the effect of 11 different preoperative factors on the clinical success of repaired root perforations.

### Gender

Previous studies have found no significant differences among gender.<sup>[19]</sup> Contrary to this, Pontius *et al.*<sup>[17]</sup> reported perforations in 32 females and 17 males. Another retrospective study also reported 39 perforations in females and 14 in males.<sup>[20]</sup> Similarly, in this review, we have found root perforations in 36 females and 24 males. In addition, there was a higher success rate for perforation repairs in female patients than in male patients in one study,<sup>[17]</sup> although other research<sup>[21]</sup> did not detect major gender differences. The present case deals with male patient.

### Age

Seltzer *et al.*<sup>[19]</sup> found more perforation in the older age group and Tsisis *et al.*<sup>[5]</sup> reported the mean age of perforation as 41.2 years. This may be attributed to a combination of various anatomic, physiologic, and pathological age-related factors.<sup>[5]</sup> Age changes may result in the apposition of secondary dentin, narrower root canals, and more apical cementum. The review of the literature shows the frequency of perforation at various ages as: 5 cases at 13–20 years, 21 cases at 21–30 years, 17 cases at 31–40 years, and 18 cases in ≥41 years. The patient was 41 years old in this reported case.

### Jaw

There were significantly more perforations in mandibular (53 cases) than maxillary molars (9 cases) which can be attributed to the degree of curvature and the presence of a dumbbell-shaped mesial root in mandibular molars with

severe distal concavities.<sup>[22]</sup> Among the mandibular molars, the most common root to be perforated was the mesial root (24 cases) followed by the distal root (9 cases). The specified canal in the mesial root was the MB in 9 cases and the ML canal in four cases. The distal canal was perforated mostly due to postspace preparation. In the remaining cases, the pulp floor or furcation area was perforated. Among maxillary molars, the furcation area was perforated most frequently, followed by MB root (2 cases) and palatal root (1 case).

A retrospective study by Tsisis *et al.*<sup>[5]</sup> and Pontius *et al.*<sup>[17]</sup> also showed more perforation in mandibular molars, contrary to the study of Kvinnsland *et al.*, which shows more perforation in maxillary molars.<sup>[4]</sup> One study concluded that there was no significant difference in the occurrence of perforation between the jaws.<sup>[23]</sup>

### Location of perforation

The site of perforation is essentially one of the most critical factors affecting the treatment outcome. Perforation in the apical and middle third of the root has a better prognosis than perforation in the cervical third of the root or in the pulp chamber floor.<sup>[24]</sup> Fuss and Trope<sup>[2]</sup> emphasized the level of crestal bone and epithelial attachment as “critical zone” affecting the prognosis of treatment. This is due to the susceptibility of these perforations to down-growth of the gingival epithelium and rapid pocket formation.<sup>[4,6,24]</sup> Similarly, the furcation area of multi-rooted teeth is also critical due to its proximity to the gingival sulcus and biological width and its anatomic complexities.<sup>[23]</sup> Tsisis *et al.*<sup>[5]</sup> in their retrospective study showed that all the crestal perforations were associated with pathological changes in adjacent periapical tissues. In the present review, 26 cases presented with pulpal floor perforation, 23 cases with coronal root perforation, 10 with middle root, while 3 cases with apical root perforation. In the current reported case, the perforation was present in the coronal part of the ML root.

### Etiology of perforation

Iatrogenic perforation was reported in nearly all of the cases in this review. Endodontic files, burs, and endodontic posts were all identified as causes of perforation in 22 cases, 22 cases, and 6 cases, respectively. However, perforation in few cases was due to internal root resorption (6 cases) and caries (1 case). A retrospective study by Pontius *et al.* showed that perforation was caused by burs, instruments, and post in 19, 16, and 11 cases, respectively, while 2 cases each were due to external and internal resorption.<sup>[17]</sup> In contrast, one study found that of all injuries during treatment, 21.5% were for perforations made during post space preparation, while 7.5% were for perforations made during root canal treatment.<sup>[25]</sup> Similarly, another study

evaluated 55 perforations and found that 53% of the perforations occurred during postspace preparation while 47% occurred during root canal treatment.<sup>[4]</sup> However, neither conducted statistical analyses.

The etiology in the presented case was iatrogenic, caused by bur in search of a canal orifice, by a general practitioner. According to a recent systematic review, the most common factors associated with perforations were the experience of the operator, tooth type, and tooth morphology.<sup>[15]</sup> The mandibular molar, particularly its mesial root is more susceptible to mechanical exposure due to the frequently present concavity on the root distally and its slender mesiodistal dimension.<sup>[15]</sup>

### Size of perforation

The size of the perforation is another important factor affecting the prognosis. Large perforation is usually associated with tissue destruction and inflammation.<sup>[2,5]</sup> Tsesis *et al.*<sup>[5]</sup> evaluated the combined influence of perforation size and location on the presence of associated pathological changes in the adjacent periodontal tissues and found more cases of associated pathological changes being associated with large perforations. However, Pontius *et al.*<sup>[17]</sup> and Mente *et al.*<sup>[20]</sup> found no significant difference between the size of perforation and treatment outcome of healing. Small (<1 mm) and medium (1–3 mm) perforations had a success rate of 100%, while a success rate of 83% was seen in cases of large perforation.<sup>[17]</sup> A tubular perforation of diameter 2 mm was found in the present case.

### Type of repair material

MTA is still a widely accepted and most commonly used repair material for intra-alveolar perforations and was also used as the repair material in the present case. Of the 62 cases in this review, perforations were repaired by MTA in 35 cases. Perforation repair with CEM and IRM accounts for 2 cases each. Gutta-percha-7, amalgam-7, calcium hydroxide-6, Portland cement-2, and Biodentine-1 were used to restore the perforation. A large number of animal studies<sup>[26,27]</sup> have confirmed the biocompatibility of these materials and the positive outcome of perforation repairs with newly formed bone. Many human studies, mostly based on case reports<sup>[28-31]</sup> and retrospective studies<sup>[17,20]</sup> further illustrated the advantages of MTA. In a meta-analysis, in 188 repaired perforations, a weighted overall success rate of 72.5% was reported, regardless of materials used but with MTA the success rate was 81%.<sup>[18]</sup> In another study, Pontius *et al.*<sup>[17]</sup> reported the success rate of 92% with MTA and 85% with other materials, but the results were statistically not significant. Similarly, Mente *et al.*<sup>[20]</sup> detected healed rate of 86% in perforations

exclusively repaired with MTA. Though MTA is known to possess the most favorable properties for perforation repair, it has certain drawbacks, including long setting time, high cost, difficult handling, and tooth discoloration. Other materials like CEM and Biodentine are devoid of these disadvantages and demonstrate promising results.<sup>[32]</sup> Still, there is a need of more scientific research and clinical studies for these materials to be used for perforation repair.

### Type of treatment (surgical or nonsurgical)

Majority of the cases (42 cases) in this review were treated nonsurgically; 9 cases were repaired surgically, while 11 cases were treated using both nonsurgical and surgical techniques. In severe furcation involvement cases, one author has reported reimplantation,<sup>[33]</sup> and one other has implemented the tunneling technique.<sup>[34]</sup> There was no difference in terms of success rate in both the treatment modalities, which is consistent with the results of Pontius *et al.*<sup>[17]</sup> However, owing to the paucity of data on surgical repair, previous research typically only investigated the outcome of the nonsurgical repair. Of the 17 studies acknowledged for systematic review by Siew *et al.*,<sup>[18]</sup> they found only 1 study<sup>[35]</sup> that focused on surgical repair.

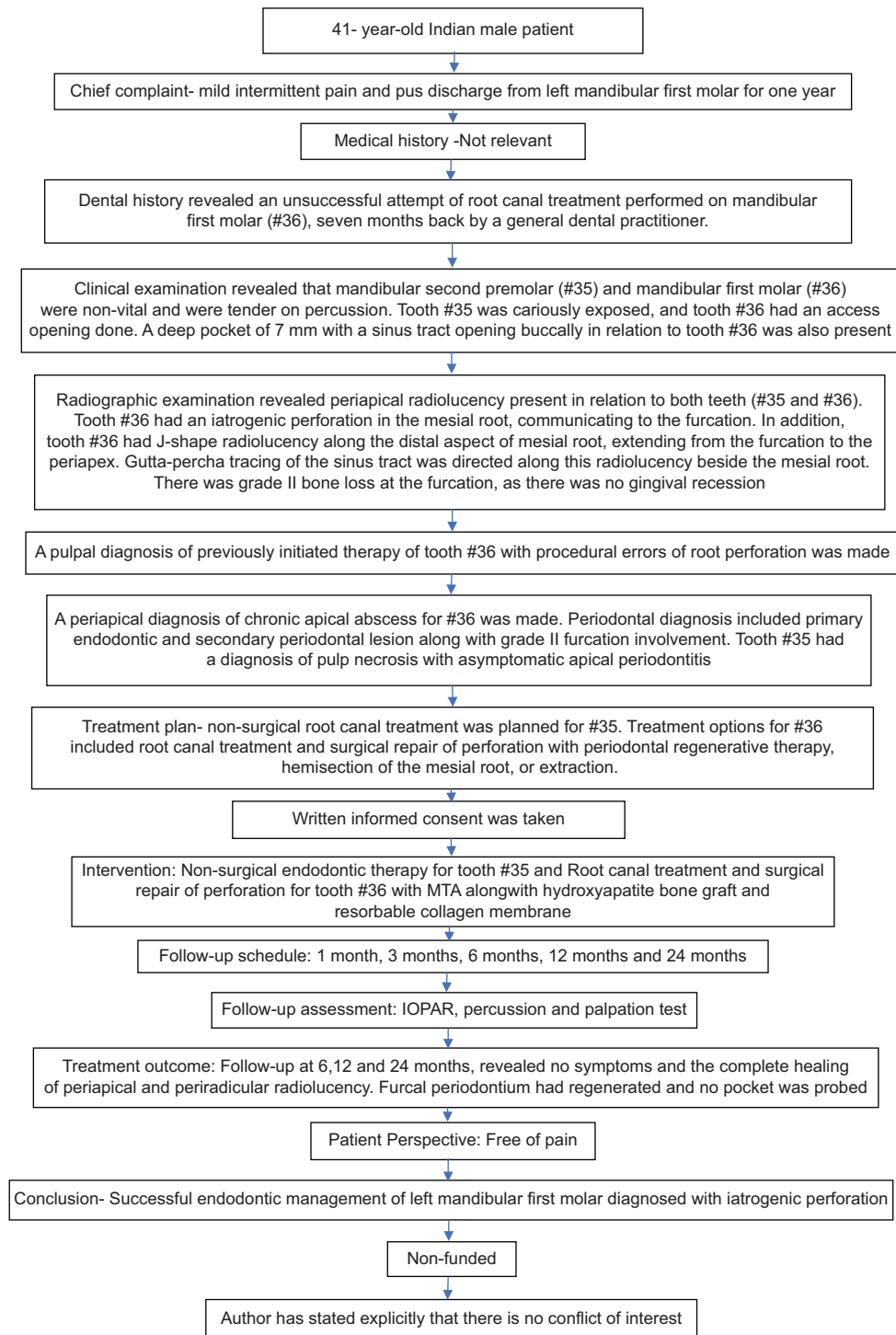
Furcation defects can be treated using a non-surgical or surgical approach, but studies have shown that nonsurgical treatment has limited results.<sup>[36,37]</sup> Siew *et al.*<sup>[18]</sup> concluded that non-surgical repair of root perforation results in a success rate of 73%. Surgical access to the furcation area facilitates complete calculus removal, accessibility, and easy placement of materials like bone grafts, PRF, and GTR barriers. Therefore, in the case reported here, the surgical repair of the endo-perio defect was preferred.

Bone grafts offer several advantages in tissue regeneration, including space maintenance for selective cell repopulation and osteoconductive/osteoinductive properties.<sup>[38]</sup> In the present case, hydroxyapatite bone graft was used because of its biocompatibility and osteoconductive properties, which allow migration and apposition of osteoblasts at the material surface.<sup>[38]</sup> The use of anorganic bovine-derived hydroxyapatite matrix provided favorable results in grade II furcation involvement in a study conducted by Eto *et al.*<sup>[39]</sup>

Various bone grafts used in the cases reviewed included: hydroxyapatite,<sup>[40]</sup> demineralized freeze-dried bone allograft,<sup>[14,40]</sup> perioglass,<sup>[41]</sup> emdogain with xenogenic bone graft,<sup>[11]</sup> and PRF with hydroxyapatite.<sup>[42]</sup>

### Guided tissue regeneration technique

In addition to bone graft, the management of grade II furcation defects requires GTR, an effective treatment



**Figure 4:** PRICE 2020 flow chart

modality for periodontal reconstructive surgery. Clinical studies suggest that GTR can improve the response of class II furcation defects by the reduction in pocket depth, gain in clinical attachment levels, and bone defect fill.<sup>[41]</sup> Improvement in these clinical parameters and the potential for establishing new attachment has led to the consideration of GTR in the present reported case. Only 7 clinical case reports: Duggins *et al.*,<sup>[14]</sup> Goon and

Lundergan,<sup>[43]</sup> Jantarat,<sup>[44]</sup> Barkhordar and Javid,<sup>[45]</sup> Zenobio and Shibli,<sup>[46]</sup> Bains *et al.*,<sup>[47]</sup> and Azim *et al.*<sup>[11]</sup> have exhibited the application of GTR technique in cases of molar root perforation with bone loss.

The barrier material used for GTR in these cases was: nonresorbable Goretex membrane in 2 cases,<sup>[14,43]</sup> resorbable collagen membranes, as in the present case,

in 4 other cases,<sup>[12,18,44,46]</sup> and PRF membrane barrier in 1 case.<sup>[48]</sup>

### Failed cases

There were 6 failed cases among the reviewed case reports.<sup>[28,40,49]</sup> Almost all these cases of failure had furcation defects due to coronal root or pulp floor perforations. Long-standing mid root perforations can also lead to periodontal involvement and subsequent furcation defect.<sup>[40]</sup> These cases were treated surgically with the materials having less sealing ability, i.e., gutta-percha, calcium hydroxide, and amalgam, also without any regenerative aid. *Apicomarginal* defect with perforation failed when treated nonsurgically, even with the use of MTA as repair material.<sup>[28]</sup> In severe cases of bone loss, when apicomarginal defect ensues, surgical treatment and GTR become imperative.

Within the limitation of this review, it can be observed that (1) mandibular molars were more encountered with perforation than maxillary counterparts; (2) pulp floor perforation is more common type; (3) more chances of perforation are during access cavity preparation and biomechanical preparation; (4) nonsurgical repair with MTA were the main treatment modality; and (5) Better clinical success of the reported cases could be attributed to the newer bioceramic materials.

### CONCLUSION

Although case reports demonstrate lowest levels of evidence, it continues to deliver new management approaches and validates techniques relevant for clinical practice, research and medical education. Root perforation at the crestal level is the most difficult to treat because of the concomitant periodontal involvement. Multirrooted furcation defect necessitates periodontal regeneration via bone grafts and GTR to ensure a good prognosis. Bioceramic materials such as MTA, Biodentine, and CEM have shown promising results in repairing perforation and reattachment of periodontium. The dentists should be motivated throughout their entire career to learn about variations in root canal anatomy and clinical training in new technologies such as CBCT, dental operating microscope, etc. Proper case selection, immediate sealing, and periodontal regenerative therapy with bone graft and GTR can be a valuable approaches to increase the tooth's longevity.

This case report was prepared according to the PRICE 2020 Guidelines [Figure 4].<sup>[50]</sup>

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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