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Resection of Multirooted Teeth: A Still Valid Treatment of Periodontal Disease with Representative Cases

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Abstract | **Case Series**

Root resection is an old dental treatment modality that is still currently used in the management of periodontal disease affecting multirooted teeth with furcations. This article explores this dental treatment modality, its history, and its use. This concept of dental treatment is illustrated by some representative cases done in a periodontal practice within primary healthcare settings with some learned lessons explained.

Keywords: Root resection, periodontal disease, dental treatment modality.

INTRODUCTION

Multirooted teeth present a unique challenge when affected by periodontal disease. When resorption of bone due to periodontal disease extends into the bifurcation or trifurcation areas of a multi-rooted tooth, this is called a Furcation Involvement (FI) [1].

Furcation Involvement is associated with increased risk of tooth loss in patients who receive supportive periodontal therapy and those not receiving it [2-9]. The commonest Furcation Involvement classification currently used includes measurement of the horizontal extent of Furcation Involvement [10], and its vertical extent [11, 12]. In the 2018 classification of periodontal diseases, class II and III Furcation Involvement is a determinant of the stage of periodontitis [13]. Thus, proper diagnosis of periodontal disease is unlikely without the score of Furcation Involvement.

Management of Periodontal Disease

Periodontal health is the "sine qua non," a prerequisite, of successful comprehensive dentistry [14]. Several Models were developed for Periodontal Treatment planning within the context of comprehensive dental treatment plans. The Trimertic model of periodontal treatment planning was introduced in 2014 to outline the order of steps in treatment of periodontal disease. It is a nonlinear model that emphasizes the re-evaluation of treatment results before moving from a stage to another in the treatment plan with the steps arranged in clockwise manner and with the multidisciplinary nature of the treatment of dental and periodontal treatment emphasized as outlined in the figure below [15]:

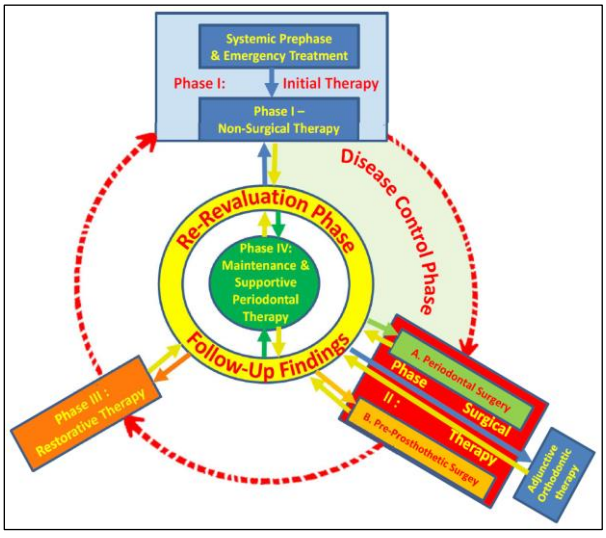


Figure 1: Periodontal treatment planning: the Extended Trimeric Model [15]

Historical Perspective:

Root amputation, separation, resection, Tooth trisection, and hemisection are surgical treatment modalities utilized in the treatment of some multirooted teeth since early days of Dentistry. Sommer RF, *et al.*, 1966 [16] attributed the first root end resection to Désirabode in 1843. Antoine Malagou Désirabode came from a line of high-end French dentists (his father was a dental health officer and dentist to the King) and

published a treatise in dentistry well known in the 19th century which was translated to English [17]. Magitot in 1867 was performing complete root removal or root resection (amputations) as documented by Prinz in his Dental Chronology published in 1945 [18].

Farrar in his classic 1884 paper [19] advocated the removal of the offending part of the tooth roots (root end resection or root ambutation) as a more conservative option than the more radical treatment by extraction of the offending tooth, reporting 9 years of practicing that. He wrote: If an entire tooth should be extracted from a diseased socket, the treatment might be termed highly radical, so far as the socket itself is concerned. . . . But, taken in connection with the preservation and usefulness of a valuable tooth, such treatment might not only be unwise and unnecessary but absolutely wrong and unscientific. . . . If such a cure will follow the extraction or the removal of an entire tooth, may it not also follow the removal by amputation of the offending portion only, if that can be done so as to leave the remaining portion of the tooth useful to the patient? Nine years of successful practice of this operation (radical removal by amputation of any portion of roots of teeth that can be of no further use) after eleven years of ups and downs in trying to save such fargone cases by the old-fashioned palliative treatment, warrants me in giving a decided reply in the affirmative.

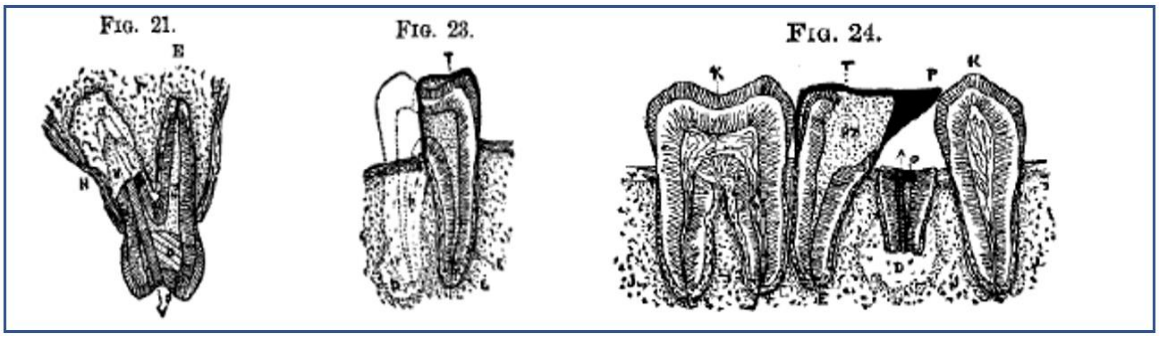


Figure 2: Cases of root resection documented by Farrar (1894) [19]

In 1886, G. V. Black in the American System of Dentistry Texbook [20] stated that: "In practice, a considerable number of cases occur in which a valuable tooth can be retained by the amputation and removal of one of its roots."

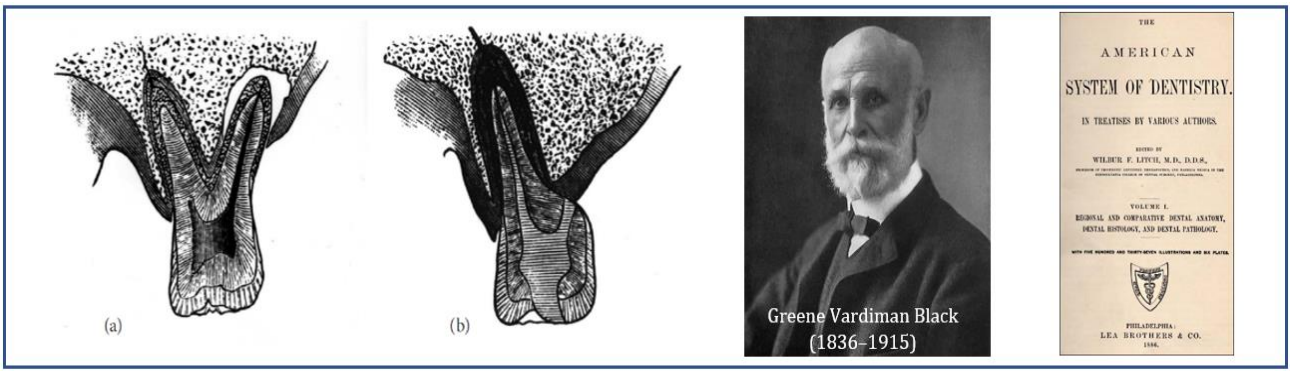


Figure 3: (a) Diagram of palatal root exhibiting extensive "pyorrhea alveolaris" or periodontal disease. (b) Tooth following root resection and osseous repair. G V Black (1886) [20]

In 1894, Younger [21] added the concept of performing root canal therapy before doing root resection for the management of periodontal disease (Pyorrhea Alveolaris) and did occlusal adjustment of root resected teeth. He wrote: . . My treatment in these cases has been to open into these (buccal) roots, remove their pulps, fill them and amputate the palatal; then grind away enough of the articulating surface of the crown, immediately over the removed root, in order to bring pressure in the effort of mastication upon the buccal roots. . . ."

With adoption of this philosophic concept (saving a natural tooth is better than removing it), it is easy to accept Farrar's proposition that saving part of a tooth (if it can be done and if it will be useful to the patient) is better than removing it. If three roots are better than two, then two roots are better than one, and one root is better than none [19].

Options in the Treatment of Multirooted teeth:

- **Hemisection** is derived from Greek, hemi meaning half, and sect, a word element occurring in loan words from the Latin in which it meant cut. Hemisection usually denotes removal of half the tooth [22, 23] done in two procedures: tooth sectioning, followed by removal of one root [24].
- **Root amputation (**Amputation is cutting off a part of the body, especially by surgery**)** refers to the removal of a root at the furcation or apical to it, without removal of the crown, usually on maxillary molars [23] or, more specifically, removal of the mesial, distal, or palatal root of a maxillary molar, leaving the other two roots.
- **Root resection** generally is defined as removal of a root, either by hemisection or root amputation, without reference to how the crown is treated [23].
- **Bicuspidization** is sectioning a mandibular molar and treating the two sections like two premolars.
- **Bisection** is separation of two roots.
- **Trisection** – Sectioning a maxillary molar to 3 sections and treating them separately.

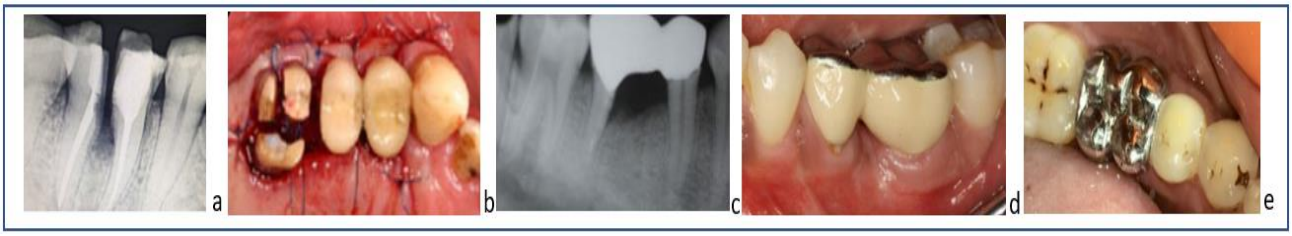
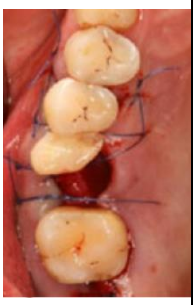


Figure 4: Options in the treatment of multirooted teeth: a) Hemisection b) Trisection c & d) Root Resection and Restoration e) Bicuspidization [22-25]

Table 1: Treatment options for maxillary molars with Furcation Involvement according to treatment invasiveness (from Walter, C., Weiger, R., & Zitzmann, N. U. 2011) [25]

0	1	2	3	4	5
Supportive periodontal therapy with **SRP** (**Scaling & Root planing**)	**Open Flap Debridement** with/without **Apically Repositioned Flap** &/or **GTR (Guided Tissue Regeneration)**	**Root Separation**	**Amputation/ Trisection of a Root:** a) DB root b) Palatal root c) MB root	**Amputation/ Trisection of two roots:** a) DB + palatal root b) DB + MB root c) MB + palatal root	**Extraction of the tooth**
		 			

The treatment of multirooted teeth with furcation involvement is an important aspect and a great challenge in periodontal therapy as they have complex anatomy and morphology contributing to procedures difficulty, favouring plaque accumulation, and limiting plaque control. Several treatment modalities have been introduced to retain furcation involved molars, such as nonsurgical and surgical mechanical debridement, furcation plasty, tunneling procedures, hemisection, root resection, and regenerative procedures [26]. Initial furcation involvement (degree I) could be successfully managed by nonsurgical mechanical debridement [26, 27]. However furcations with an advanced degree of involvement respond less favoeably to nonsurgical

therapy. This is why resective procedures, such as root resection/amputation (RR) or hemisection (H) are relatively common treatments [27, 28]. A systematic review found the success rates after resective periodontal surgery to vary between 62% and 100% after an observation period of 5 to 13 years. The most frequent complications after tunnelling procedures or root-resective therapy seem to be root fractures and caries in the furcation area [26].

The introduction of osseointegrated implants in 1982 by Brånemark and Zarb and the demonstration of success rates as high as 96.5 % in the mandible [29] provided new treatment options and raised questions about Root Resection and Hemisection procedures, leading to declined interest in the decades afterwards and a trend to extract teeth with significant periodontal involvement previously treated with Root resection and Hemisection and used as abutments to be replaced with osseointegrated implants [30]. Although implant dentistry holds a great deal of promise, it is still an invasive procedure, more financially demanding, and is not free of complications, with a systematic review based on a European consensus conference revealing that the prevalence of periimplant mucositis and peri-implantitis ranges from 19% to 65% [31]. These risks and drawbacks of implant dentistry may lead to renewed interest in traditional periodontal surgery, including Root Resection and Hemisection, with dentists facing the dilemma of deciding whether to treat a furcation-involved molar by "traditional" root-resective techniques or to replace it with an implant [32].

To aid dentists in that decision, let us look at two systematic reviews evaluating the results of both treatments. The first review was based on the latest consensus conference of the International Team for Implantology (ITI) and revealed an overall 5-year single-implant survival rate of 96.9%, technical complications of 11.8%, and biological complications of 6.4% [33]. The other review screened 1,012 publications, excluding publications that performed procedures on teeth with very poor prognoses, found the overall 5 years survival rate near (87.6%) that of single implants, with a follow-up ranging from 5 to 23 years. This comparison was mentioned as a mere indicative comment and caution was recommended by the reviewers in analysis of results [34].

A retrospective Study evaluated long term results of root resection and hemisection of 195 patients with up to 40 years of follow-up. A minimum follow-up of 5 years was needed and a molar was recorded as a survived if it was still present and functional without any signs of discomfort, pain, or pathology from restorative, endodontic, and periodontal points of view. Ninety-eight patients were excluded for not accomplishing the minimum 5-year observation period. Of the 97 remaining patients, 5 teeth were lost during the first 5 years of treatment and 92 teeth survived the follow-up period, ranging from 5 to 40 years. The overall survival rate was 94.8%. When up to 40 years of follow-up data were analyzed, it was found that high survival rates can be obtained with root resection and hemisection. The results are satisfying when a proper case selection, endodontic treatment, restorative design, and good maintenance program are given. This treatment option should always be considered before every extraction and implant placement [35].

Preserving teeth with Root Resection and Hemisection may be beneficial on many levels: [34]

1- Bone resorption of extraction sites results in narrower and shorter ridges with some clinical studies reporting the tendency of up to two-thirds of the alveolar crest resorption with lingual or palatal shift of the alveolar ridge from original position with more food impaction and more challenging oral hygiene [36-38].
2- The financial and psychologic aspects of root resection therapy with preservation of teeth can be more attractive than tooth removal and placement of an implant [39].
3- Teeth in proximity to anatomic landmarks, as the maxillary sinus and the inferior alveolar canal, can be treated safely by Root Resection therapy, especially when such proximity limits the amount of bone available for dental implants, requiring additional surgeries and costing the patient time and money [25, 40]. Current literature tend o tolerate placement of short implants in such situations, even without long-term feedback, rather than preserving teeth with conventional ways. This may be related to the fact that many practitioners consider Root Resectiom and Hemisection more challenging than dental implant placement, but, as stated by Giannobile and Lang, "We have been trained to preserve teeth. Let us face the challenge" [41].

Table 2: Requirements of Root Resection and/or Hemisection Therapy (adapted from Mokbel N *et al.*, 2019): [34]

Team Approach: a team approach is highly recommended and should be mandatory. The team should include an experienced Periodontist, Endodontist, and Restorative dental specialists.

2. Case selection:
- No involvement of two proximal furcations.
- Tooth with large divergent roots and clinical crowns.
- Good amount of bone surrounding the residual root (> 50%).
- Lack of fusion between the roots.
- Good access for oral hygiene measures.
- **Angulation and position of the tooth in the arch**: tilted molars can't be root resected (whether buccally, lingually, mesially, or distally tilted).
- **Length and curvature of roots:** long, straight roots are more favorable than short, conical roots
- Favorable crown-to-root ratio.
- Strategic value of the tooth to be retained.
- No mobility after resection and occlusal adjustment.
- Pockets must be eliminated before selection for the procedure.
- Isolated mandibular teeth should not be utilized for terminal abutments for long span fixed bridges.
- **Patient's factors:** competent oral hygiene, medical status, costs, and time.

3. Endodontic phase
- Access should be as small as possible.
- Excessive pressure should be avoided during canal preparation.
- Excessive preparation should be avoided.
- Excessive lateral condensation should be avoided, vertical obturation is preferred.

4. Surgical phase
- Atraumatic separation and extraction of the candidate root.
- Bone recontouring is necessary, positive anatomy is needed.
- Root lips and irregular contour should be eliminated (positive tooth morphology).
- Buccal and lingual 1.5-mm ferrule effect is needed.
- 3.5 mm available tooth structure between pulp chamber and residual preparation is required (2 mm for biological width and 1.5 mm for ferrule effect).
- Socket preservation of the extraction socket of the root(s) might be done.

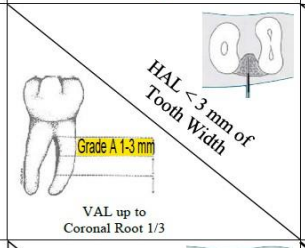
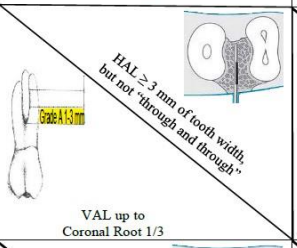
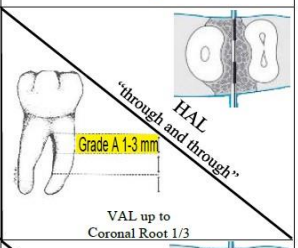
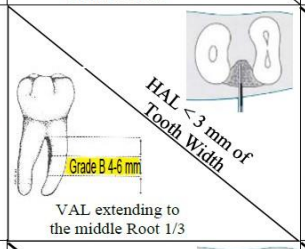
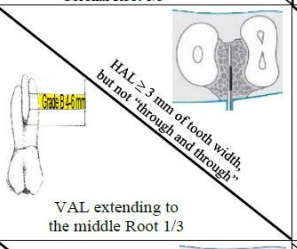
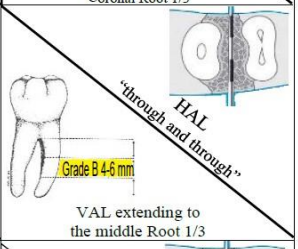
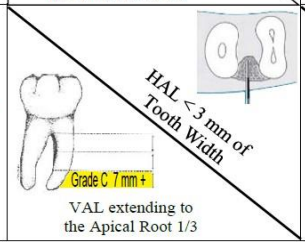
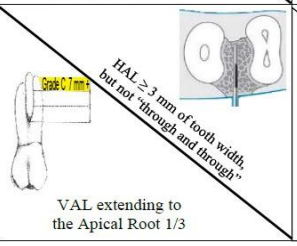
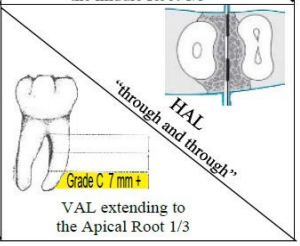
5. Restorative phase
- Use of a post should be limited. If necessary, prefabricated parallel-sided posts are preferred.
- Knife-edge finishing with metal margins are required.
- Smaller occlusal table size and smaller buccolingual width might be realized.
- Lateral forces should be reduced by making cuspal inclines less steep and eliminating balancing incline contacts.
- Molars are better restored as premolars.
- Under-contouring of the embrasure spaces.
- Crown margin should be precise and encompass the furcation.
- Crown contour should allow the patient easy access for cleaning.
- "**Sanitary pontic**" might be the best design for cleaning.

6. Maintenance phase
- Regular maintenance therapy every 4 months is necessary.
- Regular hygiene check and motivation.
- Regular occlusal check and meticulous adjustment of occlusion (often the patients should be using occlusal appliances to help reduce the forces placed on these teeth during parafunctions).
- Effective caries prevention measures are needed.

Decision Tree of the management of Furcation Involvement of Multirooted teeth (Rasperini G *et al.*, 2020): [42]

Rasperini *G et al.*, 2020 [42] provided a decision tree of recommended treatments (resective or regenerative) for multirooted teeth detailed in Figure 5. That decision tree is based on the current literature and a 3D classification of Furcation Involvement based on both past Horizontal and Vertical Classifications of Furcation Involvement as detailed in Table 3.

Table 3: 3D Classification system of Furcation Involvement (modified from Rasperini G *et al.*, 2020 [42] with figures from Tarnow & Fletcher (1984) [11] and). [**HAL**= Horizontal loss of periodontal support, **VAL**= Vertical attachment/bone loss]

Vertical component of the furcation defect [13]	Horizontal component of the furcation defect[27] 1	2	3
A			
B			
C			

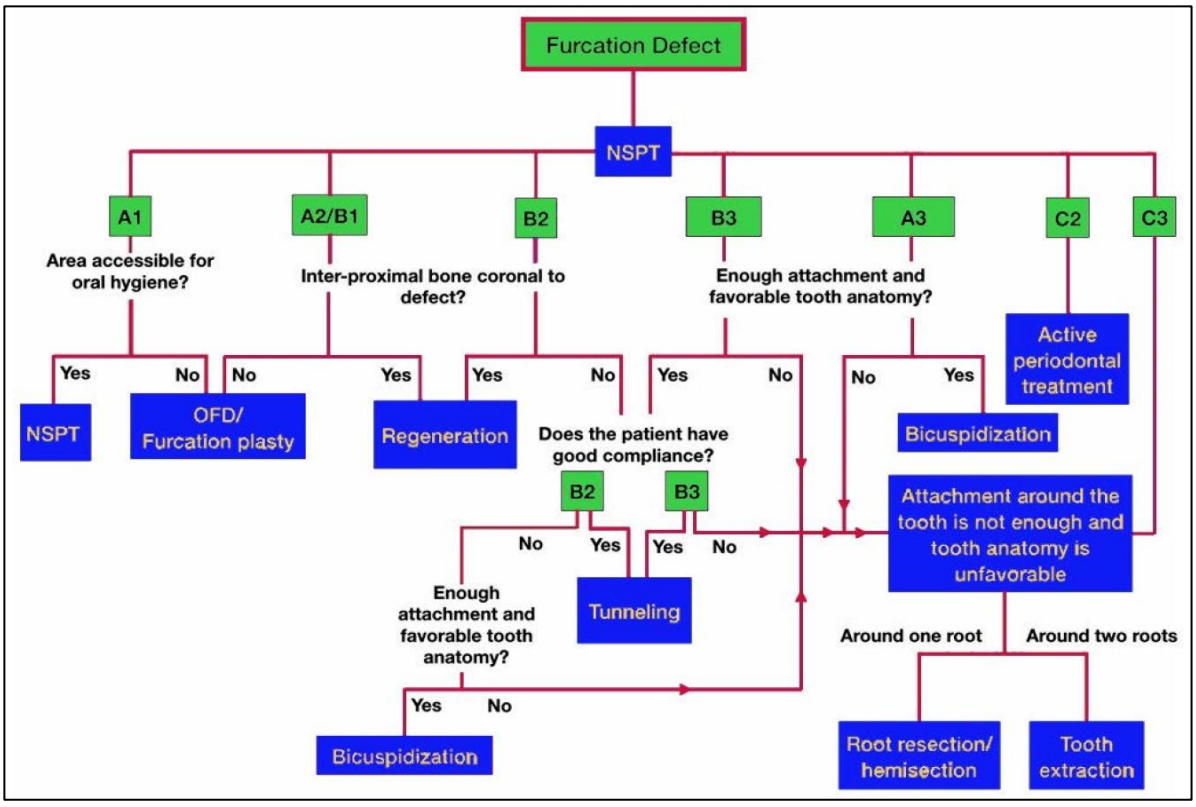
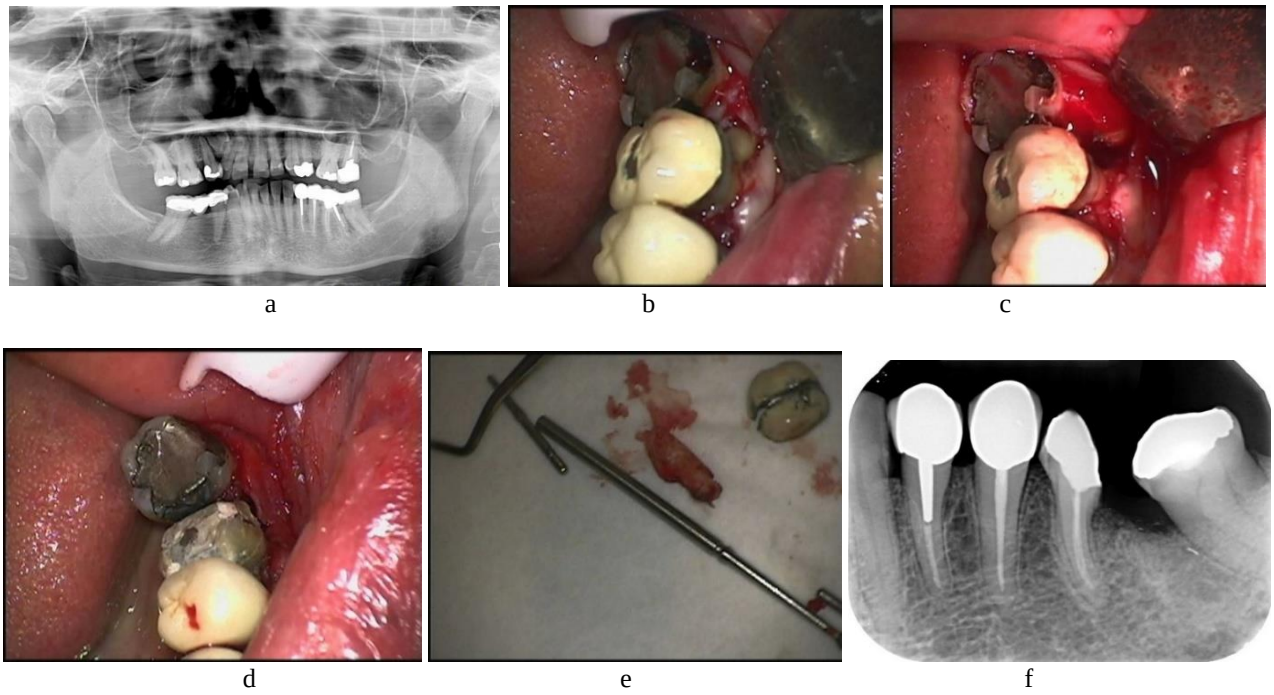


Figure 5: Decision tree for the management of a furcation-involved molar (Adapted from Rasperini G *et al.*, 2020 [42] and based on a 3D classification system of furcation Involvement detailed in Table 3). The chart is colorized with blue boxes representing treatment modalities and green boxes representing 3d furcation classes [**NSPT = nonsurgical periodontal therapy, OFD = open flap debridement]**

CLINICAL CASES

Case 1

A 52 years old diabetic patient visited our clinic in 2022 with a deep pocket distal to the crowned tooth 36 with a root filling and a large post in the distal root. the distal root was found to be fractured and distal root resection was done. The patient was referred to the prosthodontist who preferred extraction of that tooth and replacement by an implant supported crown.



a b c

d e f

Figure 6: A case of distal root resection of crowned and root filled tooth 36 referred to the prosthodontist. a. preoperative radiograph b. flap raised exposing the two roots of 36. c. resection of the distal root. d. removal of the crown and the distal segment of 36. e. The resected root. f. postoperative radiograph

Case 2

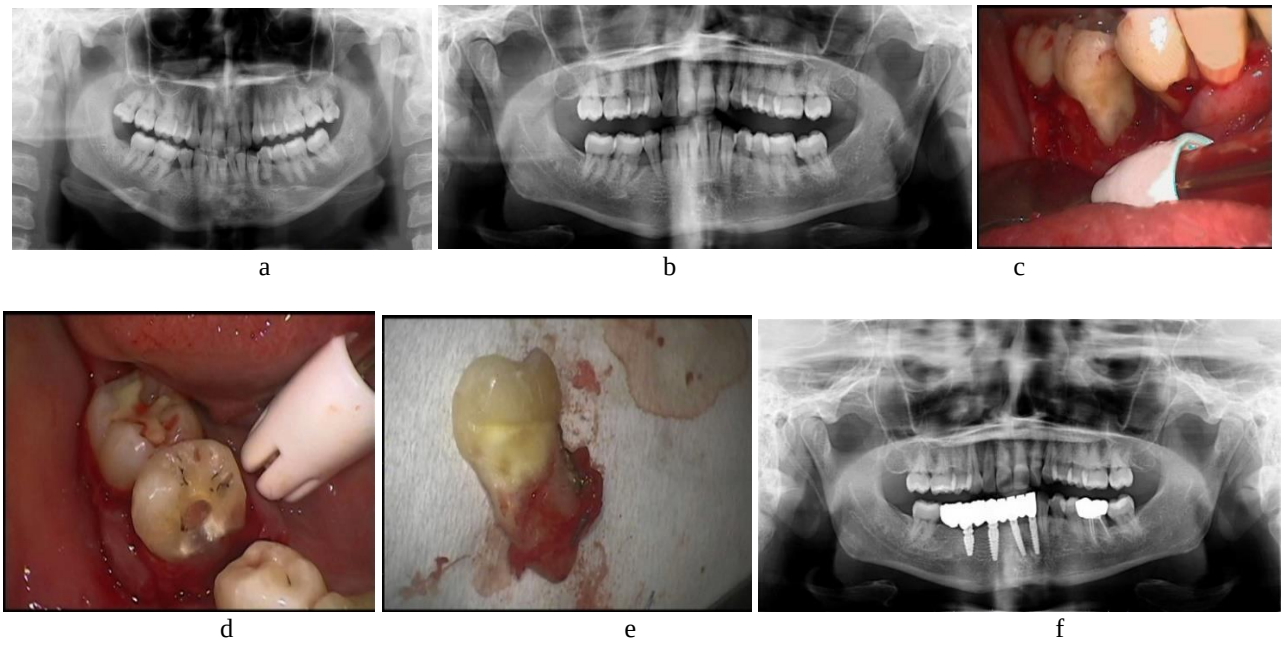
A 14 years old patient undergoing root canal therapy of tooth 46 visited our clinic in 2020 with a deep mesial pocket associated with fracture of the mesial root of 46. We did resection of the mesial root and associated crown segment and root filling was done for the patient in an effort to save her tooth. The patient is being followed up with recommendation to visit the prosthodontist for further management.

a b c

Figure 7: A case of mesial root resection of tooth 46 with fracture on the mesial root. Root filling done. a. previous radiogrph before RCT. b. Clinical radiograph showing the fracture in the mesail root. c. After root resection and root filling d. Clinical view after resection of the mesial half of tooth 46. e. Clinical view of the resected root/crown segment.

Case 3

A 32 years old female patent with diabetes and periodotal disease visited our clinic in 2019. Part of her tretment included the management of tooth 46 with a deep vertical pocket and root caries or external resorption on the mesial root. Mesial rootresection was done for 46 in 2020. The patient returned in 2023 with treatment done outside including extraction of several teeth with replacement by an implant supported bridge with a cntilever unit in place of the root resected 46 (obviusly keeping that tooth could have helped avoiding the cantilever bridge situation.



a b c d e f

Figure 8: a. OPG done in 2015. b. OPG done in 2019. c. Clinical view after raising the flap. d. Clinical view after resection of the mesial half of 46. e. Clinical view of the resection root/crown segment. f. OPG done in 2023 showing the different plan done for the patient.

Case 4

A 57 years old male patient with diabetes and periodontal disease visited our clinic in 2021 needing periodontal therapy. There was generalized gingival recession but no mobility of teeth. He had dental pain from both sides. Teeth 16, 26 were pulp extirpated. Due to the deep pocket reaching the tip of the Distobuccal root of 16, the distobuccal root of 16 was resected and root canal therapy was performed by the endodontist. Tooth 26 didn't need root resection at the time. Teeth 18 and 28 were extracted later after presenting with pulpitits. A plan for 26 distobuccal root resection is on the way as the patient has a furcation lesion related to the root filled distobuccal root. Also, a plan for implant replacement of missing second molars is also on the way.

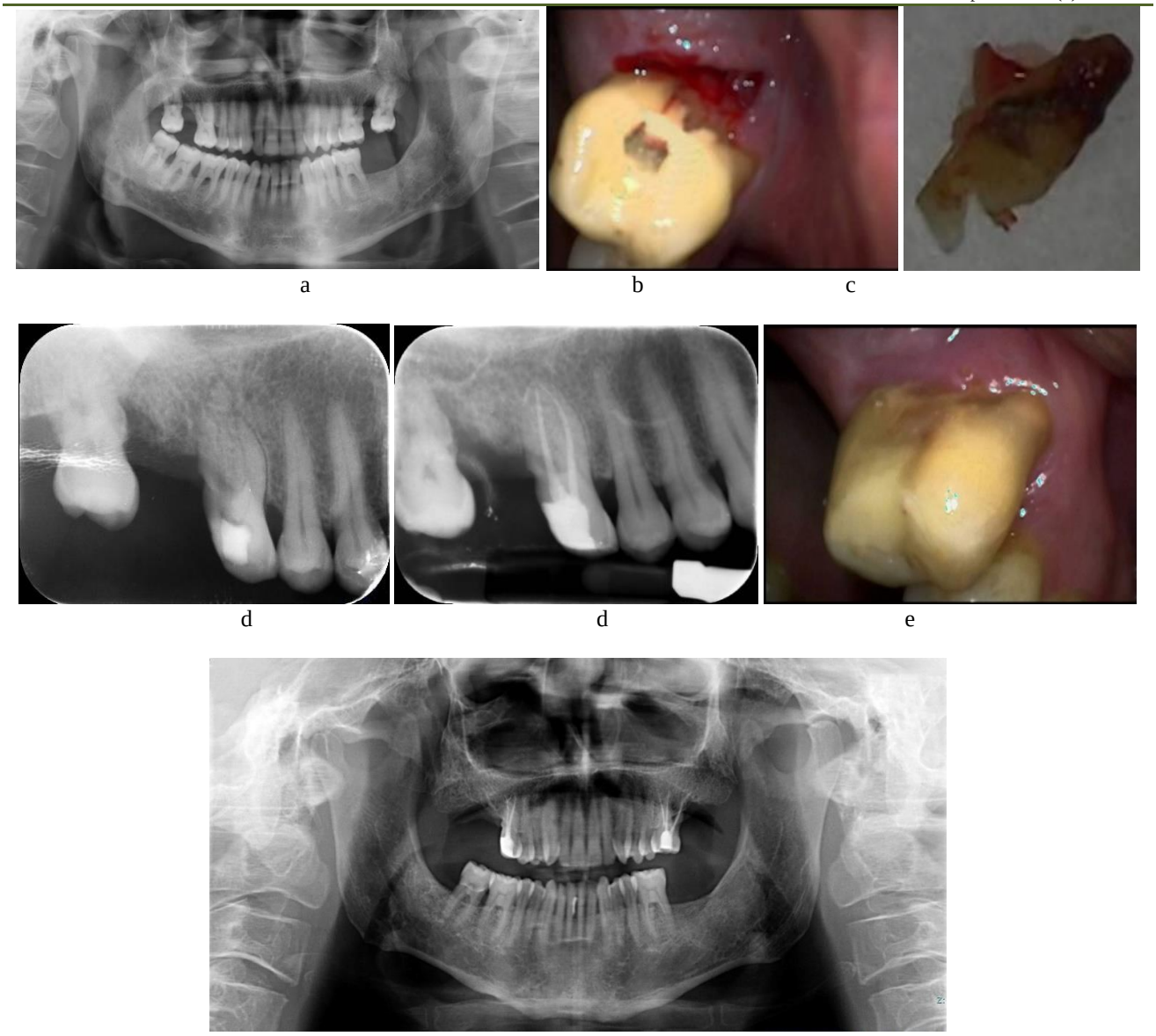


Figure 9: a. OPG done on the start of treatment on 2020. b & c. Root resection surgery photographs (August 2021). d. post root resection 16 periapical radiograph (december 2021) d. post RCT 16 periapical radiograph (August 2022) e. post root resection 16 Photo (march 2023). f. OPG after treatment of painful molars (September 2023)

CONCLUSION

Root resection and hemisection are old treatment modalities used in the management of periodontally involved multirooted teeth. They have demonstrated their utility to preserve some multirooted teeth for long periods of time. The most important aspect when undertaking them is to be done within a team that will manage the case from the surgical periodontal phase to the restorative prosthodontic phase.

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