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Risk Evaluation For Restoration of Endodontically Treated Teeth

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The best plan strategy for success should start with the end in mind. Before initiating treatment, the clinician should carefully examine and evaluate the tooth and assess it for the feasibility of endodontic treatment, restorability, periodontal health, occlusal function and esthetic needs.

Clinical diagnosis during the evaluation of the possibility to save an endodontically involved tooth has to be based on the capability to keep the tooth in function for a reasonable time.(1) Therefore, there is a need for new baseline parameters that will have to be established once the treatment goals to restore endodontically treated teeth (ETT) in different clinical conditions.

From a clinical point of view, the maintenance of an ETT for a long time reflects proper treatment planning for the tooth itself and the mouth of the patient. The diagnostic process must be based on a multifactorial approach, with a proper evaluation of each patient.

ENDODONTIC TREATED TEETH DIAGNOSTIC METHOD OF RESTORATIVE DIFFICULTY (RDES)

The RDES is a system proposed **Ferrari et al. in 2022 (2)** for the evaluation of restorative difficulty based on several clinical factors, local and more generally related to the entire mouth, whereby no single parameter displays a more paramount role. The entire spectrum of general, local and mouth parameters ought to be evaluated simultaneously. For this purpose, a functional diagram has been created (Scheme 1 and table 1) including the following aspects:

1. Endodontic complexity and outcome

2. Vertical amount of coronal residual structure and dimension of the pulp chamber

3. Horizontal amount of coronal residual structure

4. Restoration marginal seal

5. Local interdisciplinary conditions

6. The complexity of the treatment planning

7. Functional needs

8. Dental wear and esthetic need.

Each parameter has its own scale for minor,1,2 moderate,3,4 and high-difficulty5,6 profiles that can be visualized in the functional diagram from inside to outside (Scheme 1). A comprehensive evaluation of the functional diagram will provide individualized treatment planning and determine the ETT prognosis inside its treatment planning.

Endodontic complexity and outcome

Different authors pointed out the relationship between endodontic case complexity and treatment outcomes. (3,4)

endodontic complexity has a definite impact on the outcome, which is based on root canal anatomy and clinical preexisting situations such as root canal anatomy factors that are related to original root canals such as tight canals, calcified canals, apical bifurcation, complex anatomy, internal and/or external resorption, short root and iatrogenic alterations of the anatomy such as stripping and perforation. Clinical preexisting situations factors are related to apical seal and root filling, periapical lesions, crack syndrome, age of the patients, preexisting post, and degradation of collagen material. All these factors can directly influence the decision-making on the type and materials to be used for the buildup, and the final restoration (3).

The grade of Endodontic Complexity was organized in 6 degrees, from the simplest to the most difficult:

1. Vital tooth (Figures 1 and 2), 2. Necrotic single root with a periapical lesion (Figures 3 and 4), 3. Necrotic multi-root with a periapical lesion (Figures 5 and 6), 4. Complex anatomy (calcified canals, additional canals, etc.) (Figures 7–9), 5. Retreatment (Figures 10 and 11), 6. Complex retreatment (with modification of the root anatomy) (Figures 12 and 13). Individuals with vital teeth to be treated for the first time have relatively high predictability while those needing retreatment have the lowest.

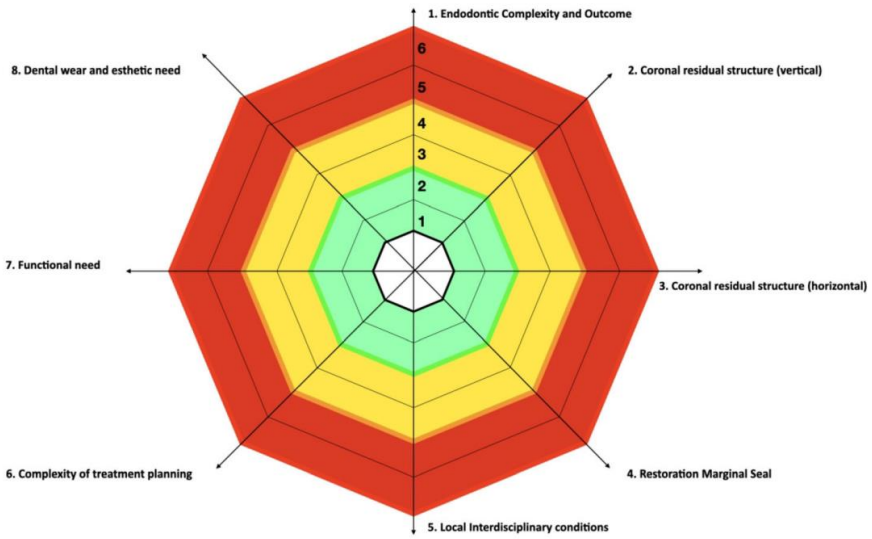
Coronal residual structure (vertical)

It is documented that the tooth becomes weaker and weaker as it progressively loses part of its coronal structure.

The amount of coronal residual structure is often described as the number of residual walls (5) but also as a percentage of the remained residual structure as well to point out the need to place a post or not.(6,7)

TABLE 1 The restorative difficulty evaluation system (RDES) reported in a table. Green area corresponds to low-risk scores, yellow area to moderate risk, and red area to high-risk scores

Score	1	2	3	4	5	6
Parameters						
Endodontic complexity and outcome	Vital tooth	Necrotic single root with a periapical lesion	Necrotic multi-root with a periapical lesion	Complex anatomy (calcified and/or additional canals, etc.)	Retreatment	Complex retreatment (with modification of the root anatomy)
Vertical amount of coronal residual structure and dimension pulp chamber	Four coronal residual walls	Three coronal residual walls	Two coronal residual walls	One coronal residual wall	One coronal residual wall	No ferrule
Horizontal amount of coronal residual structure	Absence of cervical lesions or excessive internal structure removal	A slight cervical lesion, not requiring restoration, and absence of excessive internal structure removal	Cervical lesion requiring restoration and absence of excessive internal structure removal	Absence of cervical lesions and presence of excessive internal structure removal	A slight cervical lesion, not requiring restoration, and presence of excessive internal structure removal	Cervical lesion requiring restoration and presence of excessive internal structure removal
Restoration marginal seal	Margins in the enamel and completely supra-gengivally placed	Margins partially in the enamel and dentin and iuxta-gengivally placed	Margins in dentin and supra-gengivally placed	Margins placed iuxta-gingival	Margins placed into the sulcus	Margins placed deeply into the sulcus
Local interdisciplinary conditions	No need for interdisciplinary treatment (single tooth)	Loss of attachment without the need for periodontal treatment, (single tooth)	Need for crown lengthening (single tooth)	Need for ortho extrusion and crown lengthening (single tooth)	Need for ortho extrusion and crown lengthening (single tooth)	Need for periodontal surgical therapy (bridge)
The complexity of the treatment planning	A single tooth in a virgin quadrant	A single tooth in a quadrant with other restored teeth	Tooth as the abutment of a multiunit bridge	Tooth as the terminal distal abutment of a multiunit bridge	Tooth as the abutment of a full arch rehabilitation	Tooth as the distal terminal abutment of a full arch rehabilitation
Functional need	Free-standing restoration in the favorable occlusal environment	Free-standing restoration in the unfavorable occlusal environment	Short/medium (up to 20 mm) span bridge in the favorable occlusal environment	Short/medium (up to 20 mm) span bridge in the unfavorable occlusal environment	Long span bridge in the favorable occlusal environment	Long span bridge in the unfavorable occlusal environment
Dental wear and esthetic need	No dental wear and no esthetic needs	Slight esthetic need and slight dental wear	Esthetic needs and mild dental wear	High-esthetic need and heavy dental wear	High-esthetic need and severe dental wear	Compromised function due to dental wear



SCHEME 1 The functional diagram of restorative difficulty evaluation system (RDES); eight clinical parameters are included. From the center to the boarder clinical difficulty increases in six different level. Green area corresponds to low risk, yellow area to moderate risk, and red area to high-risk category

FIGURE 1 A vital second molar in need to be endodontically treated

FIGURE 2 Same tooth at 5 years recall

FIGURE 3 A necrotic single root premolar with a periapical lesion

FIGURE 4 Same tooth at 5 years recall (3)

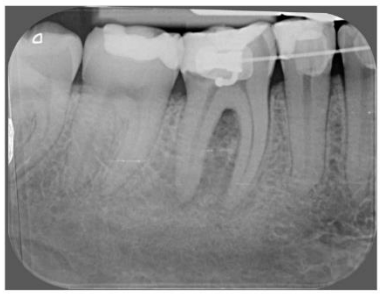


FIGURE 5 A necrotic multi-root lower molar with a periapical lesion before the endodontic treatment (ET)

FIGURE 6 Same tooth at 4 years recall

(4)

FIGURE 7 A central upper incisor with complex anatomy before the endodontic treatment (ET)

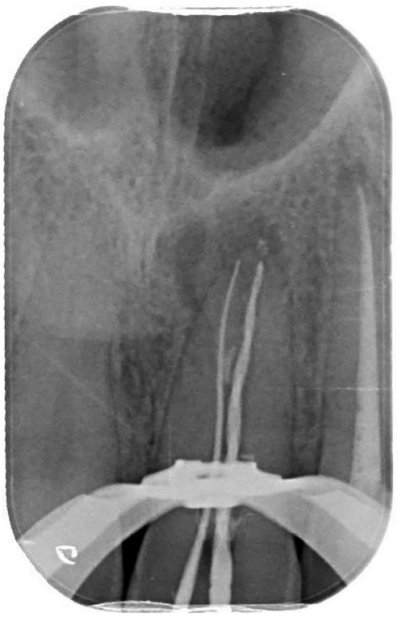


FIGURE 8 Working length of the two root canals

FIGURE 9 Same tooth at 7 years recall

FIGURE 10 A lower molar in need of retreatment before endodontic treatment (ET)

FIGURE 11 Same tooth at 7 years recall

FIGURE 12 A complex retreatment in a central incisor with modification of root anatomy (perforation due to screw post) before endodontic treatment (ET)

FIGURE 13 Same tooth at 2 years recall

The decision of using post or not is dependent on the concept of "ferrule" presence which was pointed out as the main parameter to be evaluated in ETT. The remaining amount of tooth structure can be evaluated in two aspects (horizontal and vertical).

Vertical assessment of walls depends upon the presence of coronal dentin as follows:

1. Four coronal residual walls, 2. Three coronal residual walls, 3. Two coronal residual walls, 4. One coronal residual wall, 5. Ferrule, 6. No ferrule. In the first two grades, four or three remaining residual walls(Figure 14) suggest to build up without post-placement and to use a direct restoration (mainly on anterior teeth).(8) Grades 3 and 4 might consider placing a post or not to hold the core, relating to the other parameters. Grades 5 and 6 usually need a post for the build-up. However, grade 6 shows a clinical condition in which is indicated to use the tooth as an abutment for a single crown or, after crown lengthening and/or extrusion of the root for a bridge.(9) Also, still in the vertical direction, the depth and shape of the pulp chamber must be evaluated: when is rather wide, deep, and sound the tooth structure is coronal, the build-up material can be retained inside the pulp chamber, avoiding placement of any posts.(8)

Coronal residual structure (horizontal)

The residual coronal structure must also be evaluated "horizontally," considering the presence or not of a cervical lesion and how much tooth structure was removed during the opening of the root canal system (Figures 15). Here is the description of horizontal coronal residual structure: 1. Absence of cervical lesions or excessive internal structure removal due to endo or previous condition, 2. A slight cervical lesion, not requiring restoration, and absence of excessive internal structure removal due to endo or previous condition, 3. Cervical lesion requiring restoration and absence of excessive internal structure removal due to endo or previous condition, 4. Absence of cervical lesions and presence of excessive internal structure removal due to endo or previous condition, 5. A slight cervical lesion, not requiring restoration, and the presence of excessive internal structure removal due to endo or previous condition, 6. Cervical lesion requiring restoration and presence of excessive internal structure removal due to endo or previous condition. Grades 3, 4, 5, and 6 represent rising difficulty clinical situations, till the complete loss of the buccal wall because there is no dentin left (9).

Restoration marginal seal

In the last years, the importance of the marginal seal of restorations on ETT was demonstrated. the margins of direct and indirect restoration made to restore an ETT can be placed in the enamel,(10) partially in enamel and dentin such as a partial crown or completely in dentin such as a full crown. The deeper the margin is, the more difficult it will be to keep it clean for the patient and consequently the prognosis is more uncertain.(11)

The following degrees description was made: 1. Margins in the enamel and completely supra-gingival placed, 2. Margins partially in the enamel and equi-gingivally placed in dentin (Figure 16), 3. Margins in dentin and supra-gingivally placed, 4. Margins placed equi-gingival (Figure 17), 5. Margins placed into the sulcus, 6. Margins placed deeply into the sulcus.

Local interdisciplinary conditions

Local periodontal conditions are another important factor to be evaluated. Interdisciplinary considerations should be made to assess how much sound remaining tooth structure versus restorative material will be available at the end of the treatment before final impressions.(12) It might be necessary to do a periodontal surgical therapy, to eliminate pockets or to restore mucogingival tissues.(13) In advanced perio-prosthetic cases the need for parallelism between some prepared teeth with loss of periodontal support may challenge the ETT restoration

. In some cases, crown lengthening can be combined or not with orthodontic root extrusion.(14) Teeth or roots bound to the crown lengthening procedure, with or without ortho extrusion, should be thoroughly examined and previsualized as they could appear after the completion of the treatment to decide the best pre-prosthetic option In some other cases, molars might present furcation involvement, and the treatment can be based on restoring the tooth after endodontic treatment thinking of every single root like a single tooth as for retention of the restorative material. (13)

The following degree description was therefore conceived: 1. No need for interdisciplinary treatment (single tooth), 2. Loss of attachment without the need for periodontal treatment, (single tooth) 3. Need for crown lengthening (single tooth), 4. Need for ortho extrusion and crown lengthening (single tooth), 5. Furcation involvement (tooth). 6. Need for periodontal surgical therapy.

Complexity of the treatment

Another important clinical factor to be evaluated is the complexity of the treatment. Quite often, ETT of a young patient are positioned in a quadrant without restored teeth and with normal occlusion. In this case, if a certain amount of coronal residual structure remained, a direct restoration or a partial adhesive crown might be indicated. (15)

Sometimes the endodontically treated tooth is in a quadrant with other restored teeth and the patient might need to restore the full quadrant; in this case, a quadrant of adhesive partial crowns can be indicated to better stabilize the occlusion. When partial crowns are made, the build-up of the tooth will be performed with or without a post related to the coronal residual structure and the need to retain the core material.(8) When an endodontically treated tooth is the abutment of a bridge, the tooth will be prepared for a full crown and it must be kept in mind that if a post is placed only in one abutment of the three/four-unit bridge, in case of debonding of the post, the risk of root fracture will be higher than in single restored tooth with a full crown.(9) When the endodontically treated tooth is the distal abutment of a multiunit bridge, the bridge with cantilever(s) must not be extended to avoid the risk of root fracture whether a post is used or not.(16)

The following degrees' description was therefore made: 1. A single tooth in a virgin quadrant, 2. A single tooth in a quadrant with other restored teeth, 3. Tooth as the abutment of a multiunit bridge, 4. Tooth as the terminal distal abutment of a multiunit bridge, 5. Tooth as the abutment of a full arch rehabilitation, 6. Tooth as the distal terminal abutment of a full arch rehabilitation.

The following degrees' description was therefore made: 1. A single tooth in a virgin quadrant, 2. A single tooth in a quadrant with other restored teeth, 3. Tooth as the abutment of a multiunit bridge, 4. Tooth as the terminal distal abutment of a multiunit bridge, 5. Tooth as the abutment of a full arch rehabilitation, 6. Tooth as the distal terminal abutment of a full arch rehabilitation.

Length of the edentulous area

The length of the span (edentulous area) is another impact factor related to the type of occlusion. A favorable occlusal environment is a condition in which the occlusal forces are equally distributed to the entire arches through bilaterally simultaneous occlusal contacts in maximal intercuspation position, and the excursive movements are made easy and not traumatic for the teeth by the presence of smooth lateral (canine or group function) and anterior guidance.(16) in case of malocclusion, the occlusal forces distribution could be unfavorable and may stress too much the prosthetic abutments, especially in case of ETT. orthodontic pre-prosthetic treatment should help to establish a more favorable occlusal environment contributing to a more stress-free situation for the ETT.

The following degree description was therefore created: 1. Freestanding restoration in the favorable occlusal environment, 2. Freestanding restoration in the unfavorable occlusal environment, 3. Short/medium (up to 20 mm) span bridge in the favorable occlusal environment, 4.

Figure 16: Marginal seal can be more effective when margins are placed in enamel as when a partial crown is made (10)

Figure 17: When a full crown is made and margins are placed in dentin, the marginal seal can be less effective (11)

Short/medium (up to 20 mm) span bridge in the unfavorable occlusal environment, 5. Long span bridge in the favorable occlusal environment, 6. Long span bridge in the unfavorable occlusal environment.

Dental wear and need of esthetics

The degree of dental wear and the need for esthetics are other important clinical factors to be evaluated. Dental wear can be associated with esthetic needs because anterior teeth can be shorter. However, dental wear might be of different degrees, from no dental wear to compromise function. (17) In case of heavy or severe wear, ETT already lost a wide part of coronal structure and more often the placement of a post can be needed.

The following degree description was therefore created: 1. No dental wear and no esthetic needs, 2. Slight esthetic need and slight dental wear, 3. Esthetic needs and mild dental wear, 4. High-esthetic need and heavy dental wear, 5. High-esthetic need and severe dental wear, 6. Compromised function due to dental wear.

How to Apply RDES?

RDES system can be applied on the ETT shown in (Figure 18-20):

Figure 18: Clinical and radiographic situation of third sextant. A root diagram for each tooth in the sextant, which seemed to be the most critical area was made

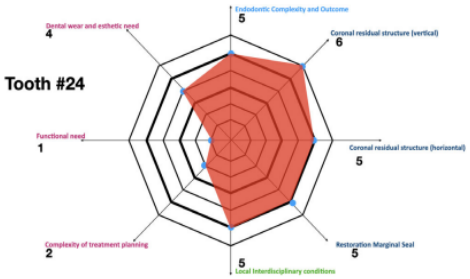


Figure Tooth 24 was classified as irrational to treat because of difficult endo retreatment due to perforation, presence of apical radiolucency, no ferrule and risk of furcation involvement in case of crown lengthening, excessive internal structure removal and presence of clenching habit. The diagnosis is coherent with the root diagram (several parameters in the high-risk category). Retreatment (5); no ferrule (6); slight cervical lesion, not requiring restoration, and presence of excessive internal structure removal due to endo or previous condition (5); margins placed into the sulcus (5); need for ortho extrusion and crown lengthening (5); single tooth in a quadrant with other restored teeth (2); free-standing restoration in favorable occlusal environment (after prosthetic treatment) (1); high-esthetic need and heavy dental wear[4]

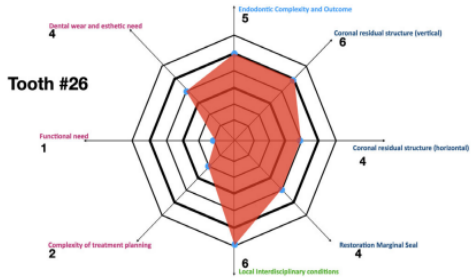


Figure Tooth 26 was diagnosed doubtful: this tooth had just been endodontically treated, it was impossible to go further instrumenting the mesio-buccal root and the endo surgery was unpredictable for this root. A root amputation was done. Retreatment (5); ferrule (5); absence of cervical lesions and presence of excessive internal structure removal due to endo or previous condition (4); margins placed iuxta-gingival (4); furcation involvement (6); single tooth in a quadrant with other restored teeth (2); free-standing restoration in favorable occlusal environment (after prosthetic treatment) (2); high-esthetic need and heavy dental wear (4). However, the diagnosis from doubtful became good after the pre-prosthetic phase, but this was not coherent with the negative root diagram (three parameters in the high-risk category). The tooth fractured after 10 years and was extracted (2)

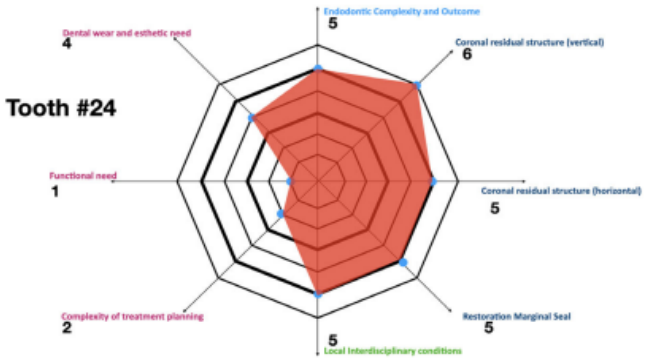


Figure 19: Tooth 24 was classified as irrational to treat because of difficult endo retreatment due to perforation, presence of apical radiolucency, no ferrule and risk of furcation involvement in case of crown lengthening, excessive internal structure removal and presence of clenching habit. The diagnosis is coherent with the root diagram (several parameters in the high-risk category). Retreatment (5); no ferrule (6); slight cervical lesion, not requiring restoration, and presence of excessive internal structure removal due to endo or previous condition (5); margins placed into the sulcus (5); need for ortho extrusion and crown lengthening (5); single tooth in a quadrant with other restored teeth (2); free-standing restoration in favorable occlusal environment (after prosthetic treatment) (1); high-esthetic need and heavy dental wear[4]

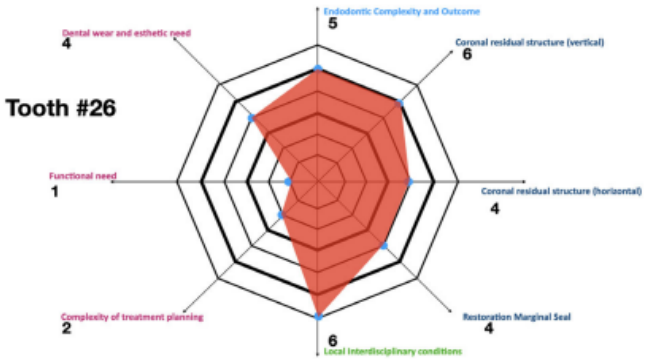


Figure 20: Tooth 26 was diagnosed doubtful: this tooth had just been endodontically treated, it was impossible to go further instrumenting the mesio-buccal root and the endo surgery was unpredictable for this root. A root amputation was done. Retreatment (5); ferrule (5); absence of cervical lesions and presence of excessive internal structure removal due to endo or previous condition (4); margins placed iuxta-gingival (4); furcation involvement (6); single tooth in a quadrant with other restored teeth (2); free-standing restoration in favorable occlusal environment (after prosthetic treatment) (2); high-esthetic need and heavy dental wear (4). However, the diagnosis from doubtful became good after the pre-prosthetic phase, but this was not coherent with the negative root diagram (three parameters in the high-risk category). The tooth fractured after 10 years and was extracted (2)

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