
An evaluation of the usefulness of two endodontic case assessment forms by general dentists

M. H. Ree¹, M. F. Timmerman² & P. R. Wesselink¹

Department of ¹Cariology Endodontology Pedodontology and ²Periodontology, Academic Centre for Dentistry Amsterdam (ACTA), Amsterdam, the Netherlands.

Abstract

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Aim To evaluate the use of two forms to assess the risks and difficulty of root-canal treatment.

Methodology Two criterion-based forms, containing 15 and 16 items, respectively, were distributed to 83 general dentists to evaluate the potential difficulty of root-canal treatment. The participants were asked to assess the difficulty of 15 endodontic cases using the Dutch Endodontic Treatment Index (DETI) and the Endodontic Treatment Classification (ETC) forms. A questionnaire was also provided to evaluate the time needed to complete the two forms, their ease of use, the clarity and/or appropriateness of the criteria and any other comments. The outcomes of the assessment were compared

with the assessment of each case as carried out by the authors.

Results The response rate was 53%. The DETI was an easy and rapid way to differentiate between uncomplicated and complicated cases. In 13 of the 15 cases, 88–100% of the dentists scored the cases in agreement with the authors. Use of the ETC form was more complicated, as a result of the larger number of variables. However, most respondents recognized the complicated cases, and 91% found the ETC form valuable to help in assessing the difficulty of endodontic cases.

Conclusions These two forms may help general practitioners to assess the difficulty of endodontic problems and to decide whether to treat the case or to refer it to a specialist.

Keywords: case classification, difficulty, endodontic treatment.

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Introduction

Although longitudinal studies of root-canal treatment outcomes have shown high success rates of up to 96% (Strindberg 1956, Kerekes & Tronstad 1979, Sjögren *et al.* 1990), the success rates noted by cross-sectional surveys are substantially lower (Ödesjö *et al.* 1990, de Cleen *et al.* 1993, Eckerbom 1993, Buckley & Spångberg 1995, Weiger *et al.* 1997, Saunders *et al.* 1997, Marques *et al.* 1998, de Moor *et al.* 2000, Kirkevang *et al.* 2000, 2001). The majority of these studies have indicated a significant correlation between the presence of an apical radiolucency

and a radiographically inadequate root filling (de Cleen *et al.* 1993, Buckley & Spångberg 1995, Saunders *et al.* 1997, Marques *et al.* 1998, de Moor *et al.* 2000, Kirkevang *et al.* 2000). Several studies have indicated that there is a substantial need for endodontic treatment in the population, and a considerable amount of this need will be in the form of retreatment (de Cleen *et al.* 1993, Weiger *et al.* 1997, Saunders *et al.* 1997, de Moor *et al.* 2000).

In order to improve the success rate of root-canal treatment in general dental practice, the referral of difficult cases to dentists with advanced knowledge and training in endodontics should be made possible for the benefit of patients (de Cleen *et al.* 1993, Saunders *et al.* 1997, de Moor *et al.* 2000). In order to be able to refer patients with complex endodontic problems, at least two requirements should be met: (i) sufficient endodontists must be available to handle the demand for specialist endodontic care;

Correspondence: Dr M. H. Ree, Meeuwstraat 110, 1444 VH Purmerend, the Netherlands (Tel.: +31 299 687131; fax: +31 299 697132; e-mail: endoree@planet.nl).

and (ii) general practitioners must be able to judge the difficulty of treatment required.

In a previous paper, it has been shown that there is a substantial need in a group of Dutch general practitioners for referring a patient with an endodontic problem to a specialist. In this survey, 93% of the respondents felt the considered need for referral, and the majority of dentists preferred to refer to an endodontist rather than to an oral surgeon (Ree *et al.* 2003).

There are no established guidelines as to when a general practitioner should refer to an endodontist. Little information is available regarding the use of standardized forms in general dental practice to assess the difficulty of endodontic cases.

Falcon *et al.* (2001) have described the development of an index of restorative dental treatment need. With this index, which also comprised the components of need and priority for treatment, clinicians determined levels of complexity of treatment for endodontics, periodontics, and fixed and removable prosthodontics. The authors found that the treatment complexity component was a practical tool capable of being used by a range of dentists.

The American Association of Endodontists has published a form which describes 17 areas that should be assessed when evaluating the potential difficulty of an endodontic situation (Curtis & Simon 1999). This form was originally generated as an educational tool for students in general dentistry, and there are no data available concerning the use of this Endodontic Case Difficulty Assessment Form in general dental practice.

The Endodontic Department of the University of California, San Francisco, has developed a similar tool for assessing endodontic cases for undergraduate care. This case-selection system, which has been used for several years, is recommended for use in general dental practice to provide a method for assessing whether to treat or to refer (Rosenberg & Goodis 1992).

The Canadian Academy of Endodontics has designed a case-classification system based on the degrees of difficulty and risk. This case-classification form has been used since 1997 in several Canadian dental schools to select cases that are too difficult for undergraduate students (Morand, personal communication). An attempt was made to test the validity of this tool, but the statistical method used covered too many variables and the results were not conclusive (Morand 1992).

The purpose of the present study was to evaluate the use of two standardized forms by general practitioners to assess the risks and difficulties of endodontic treatment.

Materials and methods

The case-classification system developed by the Canadian Academy of Endodontics (CAE) was used after adjusting several items on the form (Fig. 1a). The following criteria were added: (i) the presence of a composite core in the pulp chamber that may have a higher risk when being removed than an amalgam build-up; (ii) iatrogenic incidents such as the presence of a ledge or an apical transportation; and (iii) the presence of a sectional silver cone. The criterion whether it is possible to place a stable clamp for isolation was omitted, as this is covered by the criterion whether pretreatment is required for obtaining adequate isolation. The number of categories in the section 'tooth considerations' and the conditions that belong automatically to Class III were expanded.

In the case-classification system of the CAE, the physical status of the patient is determined by use of a physical examination system that has been proposed by the American Society of Anaesthesiology (ASA) (McCarthy & Melamed 1979). This physical status classification system of the ASA has been adopted in the Netherlands (de Jong *et al.* 1993), and therefore this criterion was used in the same way without further explanation.

With this case-classification system, endodontic cases can be divided into Class I, II or III. An explanation of how to use the ETC form is outlined in Fig. 1(b).

In order to avoid the need for every endodontic case to be assessed with this comprehensive Endodontic Treatment Classification (ETC), an additional short screening list, the Dutch Endodontic Treatment Index (DETI), was designed (Fig. 2). The DETI consists of 15 items and can be used to distinguish between an uncomplicated case (DETI score A) and a complicated one (DETI score B). If none of the 15 items of the DETI are applicable, the endodontic treatment can be considered as uncomplicated (DETI score A). In that case, there is no need for assessment in a more detailed manner with the ETC form. If one or more items of the DETI are applicable, the chance of complications is present when performing the endodontic treatment (DETI score B) and the ETC form should be used to assess the risks and difficulty of the root-canal treatment.

Initially, a pilot study was conducted amongst a group of 14 general practitioners and three endodontists to evaluate the ease of use of the two criterion-based tools in general dental practice and to obtain comments from the participating dentists. As the dentists in the pilot study assessed endodontic cases from their own practice with the two standardized forms, it

(a)

criteria	1 unit per item average risk	2 units per item high risk	5 units per item extreme risk
A. Patient considerations			
1. Medical history, anaesthesia and patient management	<input type="checkbox"/> No medical problems (ASA Class I)	<input type="checkbox"/> Special attention (ASA class II) <input type="checkbox"/> Vasoconstrictor intolerance <input type="checkbox"/> Lack of cooperation/ fear	<input type="checkbox"/> Complex medical history: (ASA class III and IV*) <input type="checkbox"/> Allergy to anaesthesia
2. Mouth aperture and physical limitations	<input type="checkbox"/> Normal mouth aperture (≥ 35 mm)	<input type="checkbox"/> Reduced mouth aperture (25-35 mm) <input type="checkbox"/> Difficulty holding radiograph	<input type="checkbox"/> Extremely reduced mouth aperture (≤ 25 mm) <input type="checkbox"/> Limited reclination
3. Radiographic difficulties	<input type="checkbox"/> Normal conditions	<input type="checkbox"/> Strong gagging reflex <input type="checkbox"/> Narrow or low palatal vault/ high mouth floor	<input type="checkbox"/> Hard to solve superimposed anatomical structures
4. Diagnosis	<input type="checkbox"/> Signs and symptoms straight forward: clear diagnosis	<input type="checkbox"/> Differential diagnosis of usual signs and symptoms	<input type="checkbox"/> Confusing and complex signs and symptoms: difficult diagnosis
B. Tooth considerations			
5. Position in the arch	<input type="checkbox"/> Anterior or premolar	<input type="checkbox"/> 1 st or 2 nd molar	<input type="checkbox"/> 3 rd molar
6. Inclination and rotation of tooth	<input type="checkbox"/> No/small inclination (≤ 10°) <input type="checkbox"/> No/small rotation (≤ 10°)	<input type="checkbox"/> Moderate inclination (10-30°) <input type="checkbox"/> Moderate rotation(10-30°)	<input type="checkbox"/> Extreme inclination (≥30°) <input type="checkbox"/> Extreme rotation (≥30°)
7. Morphological aberrations of crown and isolation	<input type="checkbox"/> Normal, original crown morphology <input type="checkbox"/> No pretreatment required for isolation	<input type="checkbox"/> Taurodontism/ microdontism <input type="checkbox"/> Simple pretreatment required for isolation	<input type="checkbox"/> Fusion/dens in dente* <input type="checkbox"/> Extensive pretreatment required for isolation
8. Access to root canal system	<input type="checkbox"/> Normal access	<input type="checkbox"/> Discrepancy between crown and root axis <input type="checkbox"/> Amalgam build-up in pulp chamber without post	<input type="checkbox"/> Porcelain fused to metal, metal or porcelain crown <input type="checkbox"/> Composite build-up in pulp chamber <input type="checkbox"/> Post/ cast post and core*
9. Canal and root morphology	<input type="checkbox"/> Canal curvature into I form <input type="checkbox"/> Small or no curvature (< 10°) <input type="checkbox"/> Anterior tooth or premolar with 1 canal	<input type="checkbox"/> Canal curvature into J form <input type="checkbox"/> Moderate curvature (10-30°) <input type="checkbox"/> Anterior tooth or premolar with 2 canals <input type="checkbox"/> Molar with ≤ 3 canals <input type="checkbox"/> Previously initiated, but not completed, endodontic treatment	<input type="checkbox"/> Canal curvature into C or S form <input type="checkbox"/> C-shape canal system <input type="checkbox"/> Extreme curvature (≥ 30°) <input type="checkbox"/> Premolar with 3 canals <input type="checkbox"/> Molar with > 3 canals <input type="checkbox"/> Canal subdivision in middle or apical third <input type="checkbox"/> Very long tooth (≥ 30 mm)
10. Apical morphology	<input type="checkbox"/> Closed (=mature) apex		<input type="checkbox"/> Open apex (immature apex/ apex resection without a retrograde filling)
11. Canal calcifications	<input type="checkbox"/> Canals clearly visible	<input type="checkbox"/> Pulp chamber/ canals are visible but quite reduced <input type="checkbox"/> Pulp stones	<input type="checkbox"/> Almost indistinctive canal path in part or throughout <input type="checkbox"/> Canals invisible*
12. Resorption		<input type="checkbox"/> Internal resorption without perforation <input type="checkbox"/> Apical resorption	<input type="checkbox"/> Internal resorption with perforation* <input type="checkbox"/> External resorption with* or without perforation
13. Iatrogenic incidents		<input type="checkbox"/> Supra-osseous perforations	<input type="checkbox"/> Broken instrument* <input type="checkbox"/> Ledging* <input type="checkbox"/> Apical transportations* <input type="checkbox"/> Sub-osseous perforations*
C. Additional Factors			
14. Retreatment of previously completed root canal treatment			<input type="checkbox"/> Retreatment of previously completed root canal treatment <input type="checkbox"/> Silver cone section*
15. History of trauma	<input type="checkbox"/> Uncomplicated crown fracture <input type="checkbox"/> Root fracture in apical third <input type="checkbox"/> Concussion	<input type="checkbox"/> Complicated crown (-root) fracture of mature teeth <input type="checkbox"/> Root fracture in middle third <input type="checkbox"/> Subluxation/alveolar fracture	<input type="checkbox"/> Complicated crown (-root) fracture of immature teeth <input type="checkbox"/> Root fracture in cervical third <input type="checkbox"/> Other luxations/ avulsions
16. Endodontic-periodontal lesion			<input type="checkbox"/> Mobility/ pocket/ fenestration / dehiscence <input type="checkbox"/> Furcation involvement <input type="checkbox"/> Root resection/ hemisection expected or completed
Subtotal	<input type="checkbox"/> x 1 =	<input type="checkbox"/> x 2 =	<input type="checkbox"/> x 5 =
*These criteria belong to Class III automatically	Total: →		<input type="checkbox"/> 15-19 units Class I <input type="checkbox"/> 20-25 units Class II <input type="checkbox"/> > 25 units Class III

Figure 1 (a) Endodontic Treatment Classification. (b) Case classification according to degrees of difficulty and risks.

(b)

- A. Contributing factors are classified into three groups: patient considerations, tooth considerations and additional considerations.
- B. Sub criteria for each category are defined and divided into three risk levels: average, high and very high.
- C. A relative weight in terms of units is assigned for each level of risk:
 - i. Average: 1 unit per item
 - ii. High: 2 units per item
 - iii. Very high: 5 units per item

D. The sum of the units is used to classify the overall case on the following scale:

Class I: Average risk (15-19 units)

Indicates that the preoperative condition is of average or routine complexity. An experienced practitioner should attain a predictable treatment outcome.

Class II: High risk (20-25 units)

Indicates that the preoperative condition is complicated. Achieving a predictable treatment outcome will be difficult for an experienced practitioner.

Class III: Very high risk (> 25 units)

Indicates that the preoperative condition is exceptionally complicated. Achieving a predictable treatment outcome will be challenging for even the most highly skilled practitioner. This treatment demands advanced knowledge and training and the use of specific armamentarium.

If all the ratings fall in the average risk category, the practitioner should feel confident about treating the tooth if he/she has experience with the procedure. It is expected that a person graduating from dental school would feel comfortable at this level. A combination of one or more ratings in the high risk category, or a single rating in the very high risk category may be the basis for consultation with a specialist, depending on the practitioner's level of experience with the particular risk(s).

Figure 1 continued

In order to assess the risks and difficulty of root canal treatment, a criteria-based list has been developed, the “Endodontic Treatment Classification”. In order to avoid the need for every endodontic treatment to be assessed with this comprehensive list of criteria, an additional short screening list has been developed, the “**Dutch Endodontic Treatment Index**” (DETI). The DETI consists of 15 criteria and it can be used to distinguish an uncomplicated case (DETI -A) from a potentially complicated case (DETI-B). If none of the 15 criteria of the DETI is applicable, the endodontic treatment can be considered as uncomplicated (score A). If one or more criteria are applicable, there is a chance of complications when performing the endodontic treatment (score B). In that case, the Endodontic Treatment Classification can be used to assess the risks and difficulty of the root canal treatment and to consider performing the treatment oneself or referring the patient.

DETI (“Dutch Endodontic Treatment Index”)

- yes
- Medical problems (ASA score ≥ 2)
 - Physical limitations/ cooperation of patient limited to poor
 - Difficult diagnosis
 - Premolar >2 canals
 - Molar >3 canals/ third molar
 - Canal subdivision in middle/ apical third
 - Moderate to extreme rotation and/or inclination of tooth ($> 10^\circ$)
 - Aberrant crown and/or root morphology/ very long tooth ≥ 30 mm
 - Pretreatment required for isolation with rubber dam
 - Crown, core and/or post present
 - Moderate to extreme canal curvatures ($> 10^\circ$)
 - Obstructions, resorption, calcification, perforation and/or open apices
 - Retreatment
 - Endodontic-periodontal lesion
 - History of trauma

None of the abovementioned criteria is applicable \rightarrow DETI score A \rightarrow Initiate root canal treatment

One or more of the abovementioned criteria is applicable \rightarrow DETI score B \rightarrow Assess grade of difficulty with the Treatment Classification form

Figure 2 Guidelines for assessing the difficulty of endodontic cases.

was not possible to compare the results between the dentists. It was only appropriate to evaluate the comments of the participating dentists concerning the use of the two lists. Adjustments were then made according to their recommendations.

Participating dentists were recruited by advertising in a newsletter provided by the Dutch Dental Association to the members of so-called ‘alpha study groups’. These study groups were founded by the Dutch Dental Association in order to enhance quality by a process of intercollegial consultation and testing. Twenty out of 152 study

groups responded to the request in the newsletter, from which 10 study groups (consisting of 83 general dentists) were selected for the study. A meeting was held for each study group, in which the purpose of the study was outlined and a selection of endodontic cases was presented so that the dentists could practise the use of the DETI and the ETC forms.

In order to compare the ratings of the participants and to investigate the validity of the two criterion-based tools, 15 cases were selected for all participants to evaluate the risks and difficulty of treatment. At the end of the

lecture, each dentist received a CD-ROM that contained the 15 endodontic cases. Each case had a brief history of the signs and symptoms and one or more radiographs. Where appropriate, cases were illustrated with clinical slides. A short explanation was provided, and the dentists were asked to assess the cases with the aid of the DETI and the ETC forms.

After completing the assessment of all 15 cases, the dentists were asked to complete a short questionnaire concerning the time needed to complete the screening forms, the ease of use, the clarity and/or appropriateness of the criteria and possible comments. Ease of use was assessed with a visual analogue scale (VAS) from 0 (easy) to 10 (difficult).

The dentists were asked to return the papers and the CD-ROM within 2 weeks. Nonrespondents were sent a reminder by mail 4 weeks later.

In order to obtain a rating with which all the outcomes could be compared, two of the authors (MHR and PRW) assessed the 15 cases using the DETI and the ETC forms. Where differences occurred, consensus was reached by discussion. The outcome was used as an experts' score with which the participants' assessments were compared.

Completed scoring lists and questionnaires were coded and entered in a database prior to analysis, which was performed using frequencies and mean values where appropriate.

Results

Forty-five (53%) of the 85 CD-ROM's, classification forms and questionnaires were returned.

DETI score

The percentage of DETI scores matching the experts' score is shown in Table 1. In 13 of the 15 cases, the dentists agreed with the experts 88–100% of the time. In one case (no. 5), a large sinus tract was erroneously considered by most dentists to be an endodontic–periodontal lesion, resulting in only 14% of the dentists rating it in agreement with the experts' score. In another case (no. 9), the radiographic image of an amalgam restoration was mistaken by most dentists as being a cast restoration (35% matching the experts' score).

Questionnaire concerning the DETI form

The majority (90%) took 1–2 min to complete the DETI form (Table 2).

Table 1 Percentage agreement with the DETI form

Case	Number of dentists who assessed the case	Agreement with experts' score (%)	Experts' rating
2	44	98	B
3	41	93	B
4	43	97	B
5	42	14	A
6	43	98	B
7	43	88	B
8	42	98	B
9	43	35	A
10	41	95	B
11	38	100	B
12	43	98	B
13	36	97	B
14	42	98	B
15	34	97	B
16	42	100	B

Table 2 Time needed to fill out the DETI form

Number of dentists	Time needed in minutes
31	1
9	2
1	4
1	5
1	10
Total number: 43	
Mean time: 1 min 35 s	

When asked to consider the clarity of the criteria used on the DETI form, 16% of the respondents regarded the criterion 'molar >three canals/third molar' as unclear. The most frequently given reason for this was that 'it is not always possible to see a fourth canal on a radiograph'. Other criteria were considered to be unclear by 0–9% of the respondents (Table 3). The most frequent comment was that these criteria are sometimes difficult to assess from a radiograph.

The DETI form was considered to be an easy tool to use by 91% of the respondents (mean VAS score 2.4) for pre-operative assessment with radiographs and a clinical examination. Only 9% of the respondents scored in the difficult part (score > 5) of the VAS scale. One-third of the respondents provided some comments, which varied from negative (too time consuming, should be used in doubtful cases only) to positive remarks (valuable tool and quite illustrative to use).

Endodontic treatment classification

A large variation (20–83% in agreement with the experts' score) was found between cases, when comparing

Table 3 Unclear criteria in the Dutch Endodontic Treatment Index (DETI) form

Respondents who found each criterion unclear (%)	DETI form
5	Medical problems (ASA score ≥ 2)
4	Physical limitations/cooperation of patient limited to poor
5	Difficult diagnosis
9	Premolar >two canals
16	Molar >three canals/third molar
3	Canal subdivision in middle/apical third
4	Moderate to extreme rotation and/or inclination of tooth ($>10^\circ$)
9	Aberrant crown and/or root morphology/very long tooth (≥ 30 mm)
9	Pretreatment required for isolation with rubber dam
3	Crown, core and/or post present
9	Moderate to extreme canal curvatures ($>10^\circ$)
7	Obstructions, resorption, calcification, perforation and/or open apices
2	Retreatment
0	Endodontic-periodontal lesion
0	History of trauma

the respondents' scores to the experts' score (Table 4). Because case nos. 5 and 9 were graded by the experts as DETI score A, they were, according to the instruction, excluded from further assessment with the ETC form. Therefore, 13 of the 15 cases were evaluated with the ETC form. Six of the 13 cases were rated according to the experts' score by 69–83% of the dentists, five cases were assessed in agreement with the experts' score by 46–64% of the dentists and the remaining two cases were rated by only 20–24% of the dentists.

One of the aims of the ETC is to differentiate between complicated (ETC Class II and III) and uncomplicated cases (ETC Class I). In 11 of the 13 cases, 70–100% of the participants were able to differentiate between these two categories (Table 5).

Table 4 Percentage agreement with the ETC form

Case	Number of dentists who assessed the case	Agreement with experts' score (%)	Experts' rating
2	43	72	2
3	38	46	3
4	42	69	3
6	42	81	3
7	35	53	2
8	41	78	3
10	39	20	1
11	38	24	2
12	42	69	1
13	34	83	3
14	41	64	2
15	33	59	3
16	42	48	2

Questionnaire concerning the endodontic treatment classification form

Ninety-three percent of the respondents needed 1–5 min to assess each case with the aid of the ETC form (Table 6).

When asked to consider the clarity of the criteria used in the ETC form (Table 7), 30% of the respondents regarded the criterion 'canal and root morphology' as unclear. The most frequently given reason for this was that 'it is not always possible to see a curvature or the number of canals on a radiograph'. Some respondents stated that the terminology regarding I-, J-, S- and C-shaped canals was confusing and could be interpreted in many ways. The other two criteria that were frequently mentioned as being unclear were the criteria 'morphological aberrations of crown and isolation' by

Table 5 Percentage agreement for differentiation between uncomplicated and complicated cases using the ETC form

Case	Number of dentists who assessed the case	Agreement with experts' score (%)
2	44	70
3	42	81
4	43	98
6	43	93
7	43	56
8	42	98
10	41	22
11	38	100
12	43	70
13	37	89
14	42	81
15	34	97
16	42	90

Table 6 Time needed to fill out the ETC form

Number of dentists	Time needed in minutes
1	<1
3	1
9	2
7	3
6	4
14	5
1	7
1	8
1	10
Total number: 43	
Mean time: 3 min 46 s	

16% of the respondents and 'canal calcifications' by 12% of the respondents. As far as isolation was concerned, some participants stated that, from a radiograph and a clinical slide, it was difficult to judge whether application of a rubber dam was possible without any pretreatment. The criterion 'canal calcifications' was considered to be unclear because this condition can be difficult to assess from a radiograph.

When asked to comment about superfluous criteria (Table 8), 7–9% thought that the criterion 'patient considerations' was not relevant, whilst 12% of the respondents considered 'canal and root morphology' as being an unnecessary criterion.

Table 7 Unclear criteria in the ETC form

Respondents who found each criterion unclear (%)	ETC form
Patient considerations	
0	Medical problems (ASA score ≥ 2)
2	Physical limitations/lack of patient cooperation
2	Radiographic difficulties
5	Diagnosis
Tooth considerations	
0	Position in the arch
7	Inclination and rotation tooth
16	Morphological aberrations of crown and isolation
9	Access root-canal system
30	Canal and root morphology
2	Apical morphology
12	Canal calcifications
7	Resorption
9	Iatrogenic incidents
Additional factors	
0	Retreatment of previously completed root-canal treatment
3	History of trauma
0	Endodontic-periodontal lesion

Table 8 Superfluous criteria in the ETC form

Respondents who found each criterion superfluous (%)	ETC form
Patient considerations	
7	Medical problems (ASA score ≥ 2)
7	Physical limitations/lack of patient cooperation
9	Radiographic difficulties
7	Diagnosis
Tooth considerations	
5	Position in the arch
5	Inclination and rotation tooth
5	Morphological aberrations of crown and isolation
7	Access root-canal system
12	Canal and root morphology
2	Apical morphology
5	Canal calcifications
2	Resorption
2	Iatrogenic incidents
Additional factors	
2	Retreatment of previously completed root-canal treatment
3	History of trauma
3	Endodontic-periodontal lesion

The ETC form was considered to be an easy tool to use by 71% of the respondents (mean VAS score 3.8) for pre-operative assessment of cases with radiographs and a clinical examination. Twenty-nine per cent of the respondents scored in the difficult part of the VAS scale (>5).

The majority of the participants (91%) found the ETC form a valuable aid in assessing the difficulty of an endodontic case.

Half of the respondents provided some comments, which varied from negative to positive remarks. Some respondents stated that the ETC form was too comprehensive and rather subjective, whereas other respondents found it to be a valuable tool to assess cases in a systematic way. Some participants found the layout difficult to read, and some suggested leaving out the average-risk items and scoring only the high- and extreme-risk items.

Discussion

The degree to which endodontic referral patterns affect the outcome of the root-canal treatment is unknown. One may speculate that, if a general practitioner treats a case beyond his or her level of expertise, then there may be a greater likelihood of iatrogenic incidents that can result in an unsuccessful treatment outcome. It

has been shown that cases treated *de novo* yield a higher success rate than retreatment cases (Bergenholtz *et al.* 1979, Sjögren *et al.* 1990, Sundqvist *et al.* 1998). Hence, if a general practitioner can recognize a difficult or complex case before treatment is initiated, then referral to a specialist can be instituted and retreatment may be avoided. In addition, if mid-treatment referral becomes necessary, then there are additional costs for the patient and the outcome of treatment may be compromised by the problem that has arisen during the general dentist's initial treatment.

The DETI form proved to be an easy and rapid tool to discriminate between uncomplicated (score A) and complicated (score B) cases. In 13 of the 15 cases, the majority of the dentists scored the same grade as the examiners, but it was evident that it was not always possible to assess every criterion from a radiograph.

The evaluation of the ETC form appeared to be more complicated, probably because of the large number of variables. There was considerable variation between cases, when comparing the respondents' scores to the experts' score. The present study shows conclusions similar to those of Morand (1992), who also attempted to test the validity of this form, but the statistical method used in that study covered too many variables and the results were not conclusive.

The assessments with the DETI and the ETC forms were not independent of each other. In case of a DETI score A (uncomplicated), there is no need for a more detailed assessment with the ETC form. When a case was erroneously considered as a DETI score A, then no further assessment with the ETC form took place. This might explain the discrepancy in the number of dentists (Tables 1 and 4) that assessed the cases with the DETI and the ETC forms. On the contrary, when a case with DETI score A was mistaken for a DETI score B, then the participants did use the ETC form. This explains why in case nos. 5 and 9 (experts' grade: DETI score A), 35 and 26 respondents, respectively, completed the ETC form.

When evaluating the ability to differentiate between complicated (ETC Class II and III) and uncomplicated cases (ETC Class I), the majority of the participants were able to differentiate between these two categories in more than two-thirds of the cases. In this respect, the ETC form served its purpose, but the number of uncomplicated cases (ETC Class I) in the present study was small. Therefore, data on the discriminative power to discern between uncomplicated and complicated cases must be interpreted with caution.

Although the ETC form contains many criteria and appears to be time consuming to fill out, the majority

of the participants needed less than 5 min to complete the form. Some participants commented that, after scoring half of the cases with the ETC form, they started to get familiar with the criteria and it took less and less time to score the last cases.

Additional canals (e.g. a fourth canal in a molar or a third canal in a premolar), anatomical configuration, the degree of curvatures, canal calcifications and very long teeth were considered to be difficult to determine on a radiograph. In the present study, the participants had to judge the presence of an extra canal from one preoperative radiograph only. In practice, this problem can be partly solved by taking two or three radiographs from different horizontal angles in order to create more of a three-dimensional picture of the root and its canal configuration. As up to 95% of maxillary first molars have four canals (Kulild & Peters 1990, Stropko 1999), the maxillary first molar could be eliminated from the DETI screening and root-canal treatment of this tooth could always be regarded as complicated (DETI score B), with the result that additional evaluation with the aid of the ETC form would be required.

The diagnostic interpretation of a radiograph is far from an objective process. Large intraobserver variations (Brynolf 1970, Goldman *et al.* 1974) and even greater interobserver variations have been reported in oral radiology (Goldman *et al.* 1974, Halse & Molven 1986). In the present study, images of the radiographs and clinical photographs of the cases to be assessed were placed on a CD-ROM, and the participants used their own computer and monitor to view the images. The type and size of the monitor screen might have influenced the quality of the image and therefore the interpretation of the radiographs (Versteeg *et al.* 1998). Additionally, there is a learning curve associated with assessing radiographs that have been digitally processed (Moystad *et al.* 1994, Wallace *et al.* 2001).

In the present study, the participating dentists had to assess the cases using clinical pictures, radiographs and a brief patient history. They were not able to perform an oral examination; so, patient factors and some of the other criteria (e.g. isolation) were difficult to interpret and might have differed from the clinical setting.

The decision whether to refer or to treat a case is probably often based on a cursory evaluation of a radiograph. General practitioners make personal evaluations as to whether to treat a case or to refer it for specialist endodontic care. This is a subjective process because every dentist has a different perspective of his or her own technical abilities. It may be argued that it will therefore

be unrealistic to develop a strict protocol for referral. However, dentists may rely on factors listed in the DETI and the ETC forms, and they may make a decision along with subjective factors such as:

- level of confidence of the dentist about his competence to perform the procedure;
- ability of the dentist to manage any possible complications during treatment;
- availability of the necessary equipment, materials and expertise for the procedure and
- possible emotional and financial consequences for the patient if mid-treatment referral becomes necessary and additional costs are incurred.

These two standardized forms may be helpful in the decision process. In addition, there is potential for them to be used as indicators for quality monitoring. No data were gathered to assess whether respondents would adopt this procedure in general dental practice. The use of the DETI and the ETC forms has been introduced recently in the undergraduate programme of the Academic Centre for Dentistry Amsterdam to select cases that are too difficult for undergraduate students. The use of the forms in dental schools and their introduction in postgraduate education may encourage more widespread use in general dental practice.

The DETI form is an easy and rapid way to differentiate an uncomplicated case from a potentially complicated one. In order to gather more information about a potentially complicated case, it might then be beneficial to fill out the ETC form and to further differentiate between a complicated and an exceptionally complicated case. The ETC form was judged as being a valuable form for assessing the difficulty of root-canal treatment by 91% of the respondents. It may not always be necessary to fill out all criteria of the ETC form to recognize an extremely complicated case. When dentists become familiar with recognizing more complex endodontic problems, they may rely on the form less often to assess case difficulty.

Conclusion

The present results indicate that the DETI form is useful to differentiate between uncomplicated and potentially complicated cases on the basis of a rapid evaluation. In addition, the ETC form was valuable for assessing cases in a more detailed manner. Results showed that this form enabled the majority of respondents to recognize extremely complicated cases. Both forms may therefore be useful for general practitioners

to assess whether a case should be treated or referred for specialist care.

References

- Bergenholtz G, Lekholm U, Milthorpe R, Heden G, Ödesjö B, Engström B (1979) Retreatment of endodontic fillings. *Scandinavian Journal of Dental Research* **87**, 217–24.
- Brynnolf I (1970) Röntgenologic periapical diagnosis. Part I. Reproducibility of interpretation. *Svensk Tandläkare Tidskrift* **63**, 339–44.
- Buckley M, Spångberg LSW (1995) The prevalence and technical quality of endodontic treatment in an American sub-population. *Oral Surgery, Oral Medicine and Oral Pathology* **79**, 92–100.
- de Cleen MJH, Schuur AHB, Wessink PR, Wu M-K (1993) Periapical status and prevalence of endodontic treatment in an adult Dutch population. *International Endodontic Journal* **26**, 112–9.
- Curtis EK, Simon DC (1999) Endodontic case difficulty assessment: the team approach. *General Dentistry* **47**, 340–4.
- Eckerbom M (1993) Prevalence and technical standard of endodontic treatment in a Swedish population. A longitudinal study. *Swedish Dental Journal Supplement* **93**, 1–45.
- Falcon HC, Richardson P, Shaw MJ, Bulman JS, Smith BGN (2001) Developing an index of restorative treatment need. *British Dental Journal* **9**, 479–86.
- Goldman M, Pearson AH, Darzentha N (1974) Reliability of radiographic interpretations. *Oral Surgery, Oral Medicine and Oral Pathology* **38**, 287–93.
- Halse A, Molven O (1986) A strategy for the diagnosis of periapical pathosis. *Journal of Endodontics* **12**, 534–8.
- de Jong KJ, Oosting J, Abraham-Inpijn L (1993) Medical risk classification of dental patients in the Netherlands. *Journal of Public Health Dentistry* **53**, 219–22.
- Kerekes K, Tronstad L (1979) Long-term results of endodontic treatment performed with a standardized technique. *Journal of Endodontics* **5**, 83–90.
- Kirkevang LL, Ørstavik D, Hörsted-Bindslev P, Wenzel A (2000) Periapical status and quality of root fillings and coronal restorations in a Danish population. *International Endodontic Journal* **33**, 509–15.
- Kirkevang LL, Ørstavik D, Hörsted-Bindslev P, Wenzel A (2001) Frequency and distribution of endodontically treated teeth and periapical periodontitis in an urban Danish population. *International Endodontic Journal* **34**, 198–205.
- Kulild JC, Peters D (1990) Incidence and configuration of canal systems in the mesiobuccal root of maxillary first and second molars. *Journal of Endodontics* **16**, 311–7.
- Marques MD, Moreira B, Eriksen HM (1998) Prevalence of apical periodontitis and results of endodontic treatment in an adult, Portuguese population. *International Endodontic Journal* **31**, 161–5.
- McCarthy FM, Melamed SF (1979) Physical evaluation system to determine medical risk and indicated therapy modifications. *Journal of the American Dental Association* **99**, 181–4.

- de Moor RJG, Hommez GMG, De Boever JG, Delmé KIM, Martens GEI (2000) Periapical health related to the quality of root canal treatment in a Belgian population. *International Endodontic Journal* **33**, 113–20.
- Morand MA (1992) Reliability study of a new evaluation tool in endodontics. *Journal of Dental Education* **56**, 63(Abstract # 117).
- Moystad A, Svanaes DB, Larheim TA, Grondahl HG (1994) The effect of cathode ray tube display format on observer performance in dental digitized radiography: comparison with plain films. *Dentomaxillofacial Radiology* **23**, 206–10.
- Ödesjö B, Hellden L, Salonen L, Langeland K (1990) Prevalence of previous endodontic treatment, technical standard and occurrence of periapical lesions in a randomly selected adult general population. *Endodontics and Dental Traumatology* **6**, 265–72.
- Ree MH, Timmerman MF, Wesselink PR (2003) Factors influencing referral for expert endodontic treatment among a group of Dutch general practitioners. *International Endodontic Journal* **36**, 129–34.
- Rosenberg RJ, Goodis HE (1992) Endodontic case selection: to treat or to refer. *Journal of the American Dental Association* **123**, 57–63.
- Saunders WP, Saunders EM, Sadiq J, Cruickshank E (1997) Technical standard of root canal treatment in an adult Scottish sub-population. *British Dental Journal* **10**, 382–6.
- Sjögren U, Hägglund B, Sundqvist G, Wing K (1990) Factors affecting the long-term results of endodontic treatment. *Journal of Endodontics* **16**, 498–504.
- Strindberg LZ (1956) The dependence of the results of pulp therapy on certain factors. An analytic study based on radiographic and clinical follow up examination. *Acta Odontologica Scandinavica* **14** (Suppl. 21), 1–174.
- Stropko JJ (1999) Canal morphology of maxillary molars: clinical observations of canal configurations. *Journal of Endodontics* **6**, 446–50.
- Sundqvist G, Figdor D, Persson S, Sjögren U (1998) Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative retreatment. *Oral Surgery, Oral Medicine and Oral Pathology* **85**, 86–93.
- Versteeg CH, Sanderink GC, Lobach SR, van der Stelt PF (1998) Reduction in size of digital images: does it lead to less detectability or loss of diagnostic information? *Dentomaxillofacial Radiology* **2**, 93–6.
- Wallace JA, Nair MK, Abomr D, Colaco MF, Kapa SF (2001) A comparative evaluation of the diagnostic efficacy of film and digital sensors for detection of simulated periapical lesions. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology* **92**, 93–7.
- Weiger R, Hitzler S, Hermle G, Löst C (1997) Periapical status, quality of root canal fillings and estimated endodontic treatment needs in an urban German population. *Endodontics and Dental Traumatology* **13**, 69–74.