ORIGINAL ARTICLE

REDUCING IATROGENIC ERRORS IN ENDODONTICS: USING THE BRITISH ENDODONTIC CASE ASSESSMENT TOOLKIT

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Background: Endodontics is supposed to be specific and require high dexterity; errors occur, which include perforation, ledge formation, or missed canals, which in turn influence the treatment outcome and patients' confidence. In hospitals, where numerous dentists work, proper case type and skill set alignment are crucial. The British Endodontic Case Assessment Toolkit (BES) is used for evaluating the difficulty of cases, provides a system that will assist in categorizing cases based on the competent professional. This research aims to identify the potential of using the BES Toolkit to minimize the rate of errors, enhance care. **Methods:** This study was conducted as a cross-sectional analysis aimed at evaluating the effectiveness of the British Endodontic Case Assessment Toolkit (BES Toolkit) in minimizing iatrogenic errors in endodontics. The study was carried out at Khyber College of Dentistry over six months, assessing 100 root canal treatment cases that had documented errors. Each case was scored using the BES Toolkit to determine difficulty levels: 17 Low (1–12), Medium (13–16), High (17–24), and High+ (>25) Ø Collected data included patient data, completion difficulty scores, practitioner type, and error characteristics. Outpatients, patients referred to the hospital from other hospitals, patients under 18 years of age, and pregnant patients who refused X-ray examination in the hospital were excluded. **Results:** A breakdown of the results also showed that 40% of errors made were in average cases, and another 40% were in the high-risk ones. The majority of errors were committed whenever GDPs practiced in areas with which they were not properly conversant with especially when the score exceeded 16. For example, stronger team communication was observed when complex cases were attended by senior staff like Dentists with Enhanced Skills (DwESEs) or senior and more experienced members of the team. **Conclusions:** The BES Toolkit also assists in proper docketing of the case in the right practitioner, depending on the level of difficulty, in a way that reverses any mistakes and increases the patient's quality of life. When this tool is integrated into practice as a common practice in hospitals, then delivery of safe and effective patient care will be enhanced.

Keywords: Endodontics; Perforation; Ledge formation; British Endodontic Case Assessment Toolkit; Patient care

INTRODUCTION

Endodontic treatment is very challenging, and to be carried out accurately, it requires the utmost precision, skill, and experience. Although these errors (perforations, ledge formation, and missed canals) are common challenges in clinical practice, these iatrogenic errors degrade the quality of treatment provided and undermine patients' confidence in dental treatment.[1] This risk is particularly high in hospital settings where a wide range of cases, from simple to complex, are treated by practitioners who have different levels of expertise. Minimizing errors and optimizing patient outcomes depends on the fact that cases are distributed based on a practitioner's skill level.

The British Endodontic Case Assessment Toolkit (BES Toolkit) is a standardized system to assess the complexity of an endodontic case and to direct the latter to those practitioners best qualified.[2,3] This tool classifies cases on a case-by-case basis by degree of difficulty so that more complicated cases are handled by more experienced personnel, potentially reducing the rate of error and improving clinical outcome.[4]

However, no studies have been conducted previously that can identify the relationship between case complexity and clinician expertise when assessed by using the BES toolkit._The purpose of this study is to determine whether the BES Toolkit can decrease the number of iatrogenic errors committed in endodontics. This study aimed to determine the proper case selection and practitioner assignment through error pattern analysis in 100 root canal cases from Khyber College of Dentistry for the improvement of patient safety and treatment success. The results of this

study will enable improvements in clinical protocols and enhance the quality of endodontic care in hospital environment.

MATERIAL AND METHODS

After approval by the Research Review Board of Khyber College of Dentistry (Notification No-147/RRB/KCD Dated 10-06-2024), data collection was started by assessing cases that had undergone iatrogenic error using the BES toolkit. A total of 100 root canal treatment cases were assessed. Initially, it was an audit-based study, but later on, we increased the number of individuals up to 100 for more generalizability of the study findings and to strengthen the results. The primary objective was to determine the relationship between case complexity, practitioner experience, and the frequency of iatrogenic errors. The cases were retrospectively evaluated using the BES Toolkit, recommended by the British Society of Endodontology for case assessment, and have been used in previous studies.[5,6] No modifications were made in the toolkit for this study. The BES toolkit categorizes endodontic cases based on difficulty levels: Low (1–12), Medium (13–16), High (17–24), and High+ (>25). Each case was classified according to these levels, and the associated errors were analyzed to determine whether there was a correlation between practitioner expertise and error occurrence. Data collected included patient demographics, difficulty scores, practitioner type (General Dental Practitioners (GDPs), Dentists with Enhanced Skills in endodontics (DwESEs), and senior specialists), and the specific nature of errors, such as perforation, ledge formation, or missed canals.

The study included only cases treated within the hospital during the study period, with complete documentation and radiographic evidence of errors.[7] Cases were excluded if they involved outpatients, referrals from other hospitals, patients under 18 years of age, pregnant patients who declined X-ray examination, or cases with incomplete records. Descriptive statistical analysis was performed to evaluate the distribution of errors across different case difficulty levels and practitioner types. The association between case complexity and error incidence was examined to determine whether practitioners were appropriately matched to their cases by using the Pearson chi-square test. Additionally, qualitative observations were made regarding team communication and procedural efficiency in cases handled by experienced versus less experienced practitioners. Ethical considerations were strictly followed, ensuring patient confidentiality and data anonymization. The study adhered to institutional ethical guidelines and focused solely on retrospective data analysis without direct patient intervention[8] By systematically assessing case allocation and practitioner expertise, this research provides insights into optimizing clinical decision-making and reducing iatrogenic errors in endodontic practice.

RESULTS

A descriptive analysis of 100 endodontic cases highlighted several important trends in case characteristics, difficulty levels, and level of provider expertise. Demographic results showed that 64% of the patients were female and 36% were male, with the mean age of 34.7years ±3.4. Most of the cases (76%) were of 1st and 2nd molars, premolars 23%, and 1% incisors and canines. On the subject of canals, most cases came with three canals (40%), two canals (24%), four canals and more (31%), and one (29%) or no canal at all. Root curvature varied among cases as well, with mild (<15 degrees) being the most common curvature (41%), moderate (15–30 degrees) was observed in 32%, and severe (30–60) and exceptional (>60) curvatures appeared to be less frequent (24% and 3%, respectively). It was found that 21% of cases were Re RCTs, and 88% of ReRCTs subjects had no previous root filling material. The root canal configuration (considering the outline, including the presence of any calcifications or pulp stones) was visible radiographically in 37% of cases, partially visible in 24%, and limited or invisible in 39%. Additionally, 68% of cases required pre-endodontic buildup, and risk factors, such as periapical lesions and structural weaknesses, were identified for 63%, again pointing to the need for careful case selection and treatment planning.

House officers did the majority of cases (70%), enhanced skilled practitioners treated 24% and specialist endodontists completed 6%. The cases scored across difficulty levels, 26% between scores of 1–16 (low to moderate), 44% between 17–24 (high), and 30% into high plus above 25, as illustrated in Table 1. The results of Table 2 emphasize that treatment errors and associated poor patient outcomes can be reduced through case allocation based on skill level. Statistical analysis of the impact of the practitioner skill level on the patient difficulty scores was also based on statistically significant differences ($p<0.001$). The primary task of house officers was to manage lower-level cases, with 36% inside scores 1–16 and 51% inside scores 17–24. Most challenging cases were assigned by enhanced skilled practitioners, with 63% of their cases categorized as difficult with

scores above 25, whereas specialist endodontists dealt exclusively with the most complex cases, and all (100%) of their cases were categorized with difficulty scores above 25. Furthermore, practitioner expertise was significantly associated with tooth type (p=0.001). Enhanced skilled practitioners and specialists saw a greater proportion of complex premolar and incisor cases but 1st and 2nd molars were still the most commonly treated teeth across all practitioner groups. The number of canals was also significantly correlated to practitioner expertise (p=0.002). In simpler cases (single canal), house officers managed 20% of cases, while 20% of cases dissected by enhanced skilled practitioners and specialists required four or more canals (46% and 33%, respectively).

Another factor that significantly varied between practitioner groups (p=0.013) was root curvature. The majority of mild curvature cases (49%) were treated by house officers, but enhanced-skilled practitioners treated a greater proportion of moderate curvature cases (58%). As expected, the more severe or exceptional curvature cases were more likely to be referred to specialist endodontists, who specialize in taking care of more complex anatomical variations. Presence of prior root filling material or pre-endodontic buildup was not found to be significantly associated with practitioner skill. However, this implies that these factors were clinically relevant but were not essential factors in determining case allocation across different levels of practitioners. Therefore, these findings underscore the need for structured case allocation according to estimated difficulty using the BES Toolkit. The results imply that more complex cases should be tended by more experienced practitioners, as it leads to better treatment outcomes and reduces iatrogenic errors. Optimizing patient safety and treatment success in endodontic practice requires careful distribution of cases, additional training, and clinical supervision.
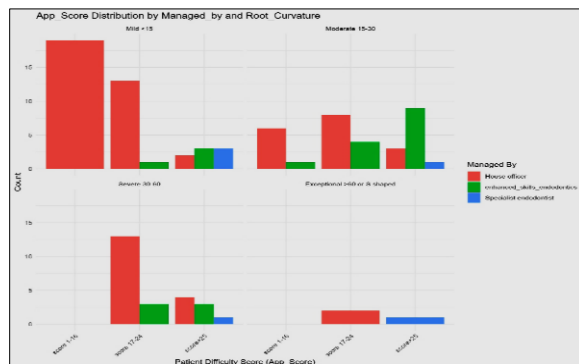

Figure-1: Distribution of Patient Difficulty Scores by Dentist Skill Level and Root Curvature

Figure-2: Heatmap of Patient Difficulty Score, Dentist Skill Level, and Root Canal Visibility

Table 1: Descriptive Characteristics of Endodontic Cases Assessed Using the BES Toolkit

Characteristic	N = 100[1]
Tooth Type	
Incisor/Canine	1 (1.00%)
Premolar	23 (23.00%)
1st/2nd Molar	76 (76.00%)
3rd Molar	0 (0.00%)
Number of Canals	
One	14 (14.00%)
Two	15 (15.00%)
Three	40 (40.00%)
Four or more	31 (31.00%)
Root Curvature	
Mild <15	41 (41.00%)
Moderate 15-30	32 (32.00%)
Severe 30-60	24 (24.00%)
Exceptional >60 or S shaped	3 (3.00%)
Re-RCT Required	21 (21.00%)
Root Filling Material	
None/Medicament	88 (88.00%)
Gutta percha	12 (12.00%)
Silver Point/ Carrier	0 (0.00%)
Other/mixed multiroot tooth	0 (0.00%)
Root Canal Visibility	
Completely visible	37 (37.00%)
Generally visible	26 (26.00%)
Partially visible	24 (24.00%)
Barely visible	13 (13.00%)
Not visible at all	0 (0.00%)
Coronal Restoration	
None direct filling material	70 (70.00%)
Indirect filling material	25 (25.00%)
Direct/Indirect intraradicular core	5 (5.00%)
Direct/indirect metal/fibre postcore	0 (0.00%)
Tooth Alignment Altered	10 (10.00%)
Pre-Endo Buildup Required	68 (68.00%)
Risk Factor	63 (63.00%)
Managed By type of doctor	
House officer	70 (70.00%)
Enhanced skills endodontics	24 (24.00%)
Specialist endodontist	6 (6.00%)
Patient Difficulty Score	
score 1-16	26 (26.00%)
score 17-24	44 (44.00%)
score>25	30 (30.00%)
[1]n (%)	

Table 2: Association of Patient Difficulty Score with Dentist Skill Level and Other Factors

Characteristic	House officer N = 70[1]	Enhanced skills in endodontics N = 24[1]	Specialist endodontist N = 6[1]	p-value[2]
Patient difficulty score?				<0.001
score 1-16	25 (36%)	1 (4.2%)	0 (0%)	
score 17-24	36 (51%)	8 (33%)	0 (0%)	
score>25	9 (13%)	15 (63%)	6 (100%)	
Tooth requiring treatment				0.001
Incisor/Canine	0 (0%)	0 (0%)	1 (17%)	
Premolar	19 (27%)	4 (17%)	0 (0%)	
1st/2nd Molar	51 (73%)	20 (83%)	5 (83%)	
3rd Molar	0 (0%)	0 (0%)	0 (0%)	
No. of canals expected to be present				0.002
One	14 (20%)	0 (0%)	0 (0%)	
Two	10 (14%)	4 (17%)	1 (17%)	
Three	29 (41%)	9 (38%)	2 (33%)	
Four or more	18 (26%)	11 (46%)	2 (33%)	
Any risk factor as identified in the BES toolkit?	40 (57%)	19 (79%)	4 (67%)	0.2
Estimated curvature of the root (most curved):				0.013
Mild <15	34 (49%)	4 (17%)	3 (50%)	
Moderate 15-30	17 (24%)	14 (58%)	1 (17%)	
Severe 30-60	17 (24%)	6 (25%)	1 (17%)	
Exceptional >60 or S shaped	2 (2.9%)	0 (0%)	1 (17%)	
What is the likely root-filling material present?				0.15
None/Medicament	64 (91%)	20 (83%)	4 (67%)	
Gutta percha	6 (8.6%)	4 (17%)	2 (33%)	
Silver Point/ Carrier	0 (0%)	0 (0%)	0 (0%)	
Other/mixed multi root tooth	0 (0%)	0 (0%)	0 (0%)	
Visibility of root canal system through radiograph				0.071
Completely visible	29 (41%)	8 (33%)	0 (0%)	
Generally visible	20 (29%)	4 (17%)	2 (33%)	
Partially visible	12 (17%)	8 (33%)	4 (67%)	
Barely visible	9 (13%)	4 (17%)	0 (0%)	
Not visible at all	0 (0%)	0 (0%)	0 (0%)	
Pre-endodontic buildup required?	46 (66%)	18 (75%)	4 (67%)	0.7
[1]n (%)				
[2]Pearson's Chi-squared test				

DISCUSSION

This research aimed to examine the utilization of the British Endodontic Case Assessment Toolkit (BES Toolkit) for structured case distribution to minimize iatrogenic errors in endodontic treatments. This study's main strength arises from being performed within an authentic dental clinical environment as opposed to a standardized laboratory environment. The BES Toolkit assessment method allowed for direct application in regular dental practice without implementing specialized equipment or extra healthcare instruments. This study involved a total of 100 cases compared to numerous previous investigations which examined fewer examples. The results from this study confirm strong associations exist between complexity levels in dental cases and practitioner practice experience showing that cases with greater difficulty level should be performed by experts to minimize iatrogenic errors and hence improve patient care. Studies have shown that complex treatment cases demonstrated higher rates of perforations along with ledge formation and missed canals based on the participation of less experienced clinicians.[9] The enactment of systematized procedures for case assignment helps decrease these potentially costly results while simultaneously enhancing the success of each patient's experience. This study's results confirm past research documenting the advantages of systematic assessments for case difficulty. Lazarski et al. research showed that treatment planning along with procedural mistake reduction becomes more efficient through proper case difficulty evaluation mostly when performed by new practitioners.[10] Digital case assessment platforms according to Essam et al. support a system that matches cases to clinical abilities by sending complex procedures to specialists who received extensive training.[7] This study, also highlights the potential of the digital app, i.e., the BES case assessment toolkit to enhance patient care and proves to be a support tool for the dentists to evaluate cases. Evaluation studies conducted by Liang et al. demonstrate that issues during endodontic treatment emerge primarily from inadequate visual diagnostics of radiographic images because doctors miss canals and provide improper root

canal fillings.[11] The BES toolkit supports these findings as it requires the clinician to answer questions that need thorough radiographic evaluation, this ensures thorough and comprehensive case assessment before initiating treatment. Previous studies show that procedural errors in dentistry mainly result from operator fatigue, excessive workloads and improper instrument choice.[12] Professional selection systems and protocols in endodontic clinical practice need particular attention especially when performed by new clinicians.[13] Healthcare facilities focusing on patient safety can lower both procedural errors and better service delivery.[14] By integrating the BES Toolkit with practitioner experience-based assignments through hospitals and training environments we can achieve excellence in service delivery to the patients. The advancement of diagnostic imaging systems and mentoring programs will contribute to enhanced case evaluation and prevention of standard procedure errors.[15]

The research methodology includes certain constraints that need to be acknowledged. This research took place in hospital facilities instead of private dental practices making findings apply differently to the conditions common in private practice settings. The examination of procedural errors did not extend to determine long-term treatment outcomes and as such this cannot prove that enhanced outcomes resulted from reduced procedural errors. The literature indicates that certain minor procedural mistakes including small ledges and minor obturation gaps might not trigger treatment failures therefore definitive outcome research should adopt a time-based approach to assess patient results.[16]

The clinical implications of these findings for endodontic practice are important. Structured case assessment enhances overall treatment success. The increasingly strong correlation between case complexity and practitioner expertise justifies the need for structured training programs and competency-based case assignment in clinical practice.[6,17] Moreover, the results underscore the need for ongoing professional development of less experienced practitioners.[13] This study highlighted the fact that house officers acted as case managers for large amounts of cases, including many of the lower difficulty score cases, but more training and close supervision would further expand their ability to handle more complex cases.

More future research is needed to examine case allocation strategies in relation to longer term treatment outcomes Further, CBCT imaging and AI powered case assessment tools have the potential to increase case difficulty evaluation accuracy, improving the patient outcomes. These data also reveal relationships between the complexity of an endodontic case, the level of expertise of the practitioner, and the resultant outcome of treatment. The results further support the role of the BES Toolkit in the structuring of case allocation, ensuring that complex cases are required to be dealt with by experienced practitioners. Aligning case difficulty with skill level, institutions can minimize iatrogenic errors, improve treatment success and improve patient safety. Future efforts should include mentorship programs, technological advancements, and continuous training opportunities to enhance endodontic care altogether.

CONCLUSION

This study shows that the British Endodontic Case Assessment Toolkit (BES Toolkit) is an effective tool for formal case allocation in endodontics and reducing the likelihood of iatrogenic risks and improving patient outcomes. The results show a strong correlation between complexity of case and practitioner experience with 'house officers managing low to moderate cases and enhanced skilled practitioners and specialist endodontists managing more complex cases'. The structured approach will avoid allowing cases involving multiple canals, severe root curvature or inadequate radiographic visibility to be treated by less experienced personnel, thus reducing the probability of procedure errors. Through BES Toolkit integration into routine practice, dental institutions can standardize case distribution, thereby creating a sure-fire recipe for case distribution to maximize patient safety and treatment success.

AUTHORS' CONTRIBUTION

FAS: Conceptualization of study design. SK, LG: Data collection, literature search. SAS: Proof reading.

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