Assessment of Clinical Reasoning and Diagnostic Thinking Among Dental Students

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Abstract

Aim and background:

Diagnostic thinking is the ultimate goal of educational system and the basis for clinical reasoning. The aim of this study was to assess the clinical reasoning and diagnostic thinking ability of dental students by key features test and Diagnostic thinking inventory (DTI) questionnaire.

Materials and methods

The present study was a descriptive cross-sectional study. The participants consisted of 61 senior dental students. Clinical reasoning and diagnostic thinking were assessed by key feature test and DTI questionnaire, respectively. To design the KF test questions, the blueprint of exam was first designed in expert panel based on dental curriculum. The questions developed based on common cases in oral and maxillofacial diseases by the group of oral and maxillofacial specialists. The DTI was developed by Bourdieu et al. in France and consists of 41 questions on a 6-point Likert scale, of which 21 are memory structure category and 20 are in flexibility in thinking category. Satisfaction of student assessed through a 10-item questionnaire. Data were analyzed using SPSS 19 by descriptive tests (mean, SD, percentage) and student independent T-test and Pearson test. Significance level was determined $p < 0.05$.

Results

The mean scores of the key features test of students were 56.55 ± 7.80 . No significant difference was reported between clinical reasoning scores of key features test by students' gender (p -value = 0.19). There was no significant difference between the scores of diagnostic thinking between men and women (p -value = 0.11). The difference in students' scores in the domain of flexibility in thinking was significantly higher among male students than female students. (P -value = 0.04). There was no significant correlation between students' diagnostic thinking scores and their clinical reasoning scores in the key features test.

Conclusion

Based on the present results, the clinical reasoning and diagnostic thinking skills of participants were reported in the low level. This issue emphasizes the need for training to enhance diagnostic thinking and clinical reasoning in dental education. Formative evaluation and reform the educational programs of this course should be considered.

Introduction

Clinical reasoning is considered as one of the most important skills required for health personnel (1, 2). Clinical reasoning is a logical thinking process that guides the health providers to take purposeful steps

in diagnosis and treatment. This process exists in all stages of dealing with the patient, from the initial stage of getting the history of the disease to the patient management and follow-up(3). Having clinical reasoning as a clinical competency is considered essential and has been introduced as one of the essential skills for conducting professional responsibility and responding to patients(4). Clinical reasoning consists of four components; data collection, clinical hypothesis formation, hypothesis testing, clinical decision making and problem-solving. Educational methods such as problem-based learning, team-based learning and cases based learning are recommended to develop the reasoning skills of medical students(5). Insufficient attention to teaching clinical reasoning skills and related concepts increases the miss diagnosis as the main cause of medical errors (6). Therefore, teaching clinical reasoning to students of medical sciences is important (7, 8). The majority of medical graduates do not achieve the correct clinical reasoning skills to diagnose and perform effective and safe interventions for patients (7, 9, 10). This topic highlights the importance of teaching critical thinking skills and clinical reasoning.

The goal of educational systems is to switch the memorization approach to the development of learners' reasoning skills and problem-solving ability (11). Clinical reasoning training actually provides students with the opportunity to achieve critical thinking, clinical decision-making, and learning in three areas of cognitive, affective, and psychomotor to prepare them for their professional role in society (12). In the dentistry, the decision-making and reasoning skills have vital role in the field of oral and maxillofacial medicine. The main activities of this field are the ability to diagnose and treat oral mucosal lesions, salivary gland diseases, and temporomandibular joint and dental management of patients with systemic diseases. Early diagnosis of oral lesions is important because many of them could be the first sign of undiagnosed systemic disease or lead to a malignant lesion with late diagnosis of a pre-malignant lesion. Currently, the dentistry curriculum mainly focuses on the development of procedural skills. Although, there is a need to change the training processes and evaluate clinical reasoning skills in school of dentistry.

The improvement of clinical reasoning among learners needs to consider in teaching and assessment process in clinical education (10, 13).

The Key-Feature (KF) test is introduced a subset of clinical reasoning tests. KF is a scenario-based clinical exam that solves the clinical problem through a number of questions about important actions or clinical decisions (13, 14). In this test, a short scenario with little information is provided to the examiner and he/she detect key information by selecting the choices. The value of responding to different options in the KF test varies and could be changed according to their values in patient's diagnosis and treatment. In KF test is assuming not all information is of equal value, but there are key points that are more important in solving the problem than other symptoms. A mistake in identifying them will cause the failure to solve the problem correctly. This test mainly focuses on more valuable points of diagnosis and treatment rather than others.

The advantages of this test include the ability to evaluate clinical decision-making, the possibility of wider coverage of clinical cases compared to other reasoning tests, the design of various forms of answers. High reliability and the possibility of more structured and focused evaluation of clinical cases introduced as the benefits of the test (15). According to studies, the KF test is a suitable test for measuring clinical reasoning skills of medical students and its score is closer to the OSCE test scores (16, 17).

Other tools were introduced to assess clinical reasoning skills. One of them is Diagnostic Thinking Inventory (DTI) (18). DTI is a tool that measures the flexibility in thinking and structure of knowledge in memory independently of content and can evaluate different degrees of medical skills(19). DTI is a suitable tool for comparative assessment of clinical reasoning ability based on their self-expression among students with different curricula. Diagnostic thinking is different from critical thinking and both are used to assess clinical reasoning (20–22). Groves et al. noted that this questionnaire is directly related to the clinical reasoning process of examinees (20). Hamzeh et al. compared clinical competency using diagnostic thinking in experienced and inexperienced physiotherapists. Their results showed that the DTI instrument had sufficient validity and reliability to assess clinical diagnostic reasoning (23). There were founded a few studies about assessing clinical reasoning and diagnostically thinking among dental students. The aim of this study was to assess the clinical reasoning and diagnostic thinking abilities of dental students through key features test and DTI questionnaire.

Method

The present study was a descriptive cross-sectional study.

Participants

The study population consisted of 61 students of the 11th semester in X dental schools who were chosen based on census method.

To design the KF test questions, the blueprint of exam was first designed in expert panel based on dental curriculum. Based on the studies (17), to achieve the desired reliability in this process, 17 questions were designed and reviewed after design (Tables 1 and 2). The questions developed based on common cases in oral and maxillofacial diseases by the group of oral and maxillofacial specialists.

Table 1
Blueprint of key-features exam

Subject area	First assessment	diagnosis	Laboratory tests	Dental management	% of exam
convulsion				1	5.8
Endocrine disorders	1	1	2		23.2
addiction				1	5.8
Renal disease	2				11.6
Gastrointestinal disorders	1	1		2	23.2
AIDS		1			5.8
leukemia		1			5.8
anemia	1				5.8
Or facial pain	1				5.8
hepatitis	1				5.8

Table 2
The detail of Key feature examination

Number of questions	Field of evaluation	disease	The goal of evaluation
1	Dental management	seizure	-Student must know the dental managements of convulsive patient
4	-diagnosis -laboratory tests(2 cases) -data collection	Endocrinal disorders	- Student must diagnose the oral signs and symptoms of Addison disease and prescribe the laboratory tests - Student should prescribe the laboratory tests for hyper thyroid patient before dental management.
1	Pretreatment consideration	IV drug users	- Student must know pretreatment consideration of IV drug users
2	On treatment consideration	Kidney	- Student must know pre-extraction consideration of kidney transplant patients - student must know pretreatment consideration of hemodialysis patients
4	-Pretreatment consideration - Dental management (2 cases) -diagnosis	gastrointestinal	- Student must know pre-extraction consideration of inflammatory bowel disease patients - Student must consider dental management of patient with history of gastrectomy. - Student must diagnose the oral signs and symptoms of Crohn disease
1	-diagnosis	AIDS	- Student must diagnose the oral signs and symptoms of AIDS
1	-diagnosis	leukemia	- Student must diagnose the oral signs and symptoms of leukemia.
1	Pretreatment consideration	anemia	- Student must know pretreatment consideration of anemic patients.
1	Pretreatment consideration	Orofacial pain	- Student must diagnose the symptoms of orofacial pain.
1	Pretreatment consideration	hepatitis	- Student must know pre-extraction consideration of hepatitis.

In order to inform students about KF test, a pilot study was conducted to familiarize them with reasoning questions at the beginning of the semester. Students spend one-month course of oral and maxillofacial diseases. All participants participated in the study with ethical considerations provided that they want to participate in the study. Key features test scores were calculated from zero to 100. In addition to the

instant feedback included in the questions, a face-to-face feedback session for students was scheduled and conducted the next day after test. Moreover, the students completed DTI test.

Instruments:

Satisfaction questionnaire consisted of 10 questions. (Cronbach's alpha = 0.85). The scoring of questionnaire was on a 5-point Likert scale. The DTI was developed by Bourdieu et al. in France and consists of 41 questions on a 6-point Likert scale, of which 21 are memory structure category and 20 are in flexibility in thinking category. Based on this questionnaire, individuals use a tool to evaluate themselves in different situations and DTI has an acceptable validity ($\alpha = 0.83$) that can distinguish between mastery and novice diagnosis (24). This questionnaire was psychometric in soltani-Arabshahi study in X context (18).

Data were analyzed using SPSS 19 by descriptive tests (mean, SD, percentage) and student independent T-test and Pearson test. Significance level was determined $p < 0.05$.

Data analysis

Data were analyzed by descriptive statistics (mean and standard deviation) and analytical tests (Pearson, student t-test).

Ethical consideration

This study was approved by the Committee of Ethics in Human Research at X. (IR.SSU.REC.1399.302). In this study, an informed consent was obtained from the participants. Eligible participants were informed about the aim of the study, the method, and confidentiality of their responses by e-mail. All methods were performed in accordance with the relevant guidelines and regulations by the ethical certification. (IR.SSU.REC.1399.302).

Results

Participants

In this study, 61 dental students participated, of which 36 were male (59%) and 25 (41%) were female. Their mean age was 23 ± 2.76 .

The mean scores of the key features test of students are shown in Table 3. No significant difference was reported between clinical reasoning scores of key features test by students' gender (p -value = 0.19).

Table 3
Clinical reasoning score of students from KF test

	Mean $\pm$ Std. Deviation	Maximum	Minimum
Clinical Reasoning Score	56.55 $\pm$ 7.80	70.00	36.71
Gender			
Male	57.63 $\pm$ 7.23	70.00	42.71
Female	55.00 $\pm$ 8.48	69.88	36.71

The students' satisfaction scores were 3.53 ± 0.52 which showed relative satisfaction about the reasoning test in the oral and maxillofacial diseases course. The lowest score was 2.27 and the highest score was 4.90. There was no significant difference between the satisfaction levels of male and female participants (p -value = 0.12). DTI score in students showed in Table 4 and 5.

Table 4
Frequency of DTI score level of students

	Number (%)	Score of DTI
Very poor	54(88.5)	< 150
poor	2(3.3)	150–155
moderate	2(3.3)	156–160
good	1(1.6)	161–165
Very good	0(0)	166–170
excellent	2(3.3)	171–246

Table 5
Diagnostic thinking scores of students in different domains

	Mean $\pm$ Std. Deviation	Maximum	Minimum
Diagnostic thinking	136.47 $\pm$ 16.45	175.00	93.00
Flexibility in thinking	72.22 $\pm$ 11.15	93.00	45.00
Structure of memory	64.24 $\pm$ 7.84	84.00	43.00

According to Table 4, there was no significant difference between the scores of diagnostic thinking between males and females (p -value = 0.11). This significant difference was not reported in the domain

of memory structure. (P-value = 0.66). However, the difference in students' scores in the flexibility in thinking domain was significantly higher among male students than female students. (P-value = 0.04). (Table 6).

Table 6
Diagnostic thinking scores of students

	Gender	Mean $\pm$ Std. Deviation	p-value
Diagnostic thinking	Male	139.28 $\pm$ 17.24	0.11
	Female	132.44 $\pm$ 14.64	
Flexibility in thinking	Male	74.66 $\pm$ 10.55	0.04
	Female	68.72 $\pm$ 11.26	
Structure of memory	Male	64.61 $\pm$ 8.42	0.66
	Female	63.72 $\pm$ 7.06	

The results of Pearson correlation showed that there was no significant correlation between students' diagnostic thinking scores and their clinical reasoning scores in the key features test ($r = 0.16$, P-value = 0.19). Accordingly, there was no significant relationship between learners' key features test scores with DTI test ($r = 0.16$, P-value = 0.19) and DTI's domains including diagnostic thinking flexibility ($r = 0.15$, P-value = 0.24) and memory structure ($r = 0.14$, P-value = 0.32).

Discussion

In this study, key features test and DTI questionnaire was used to assess the clinical reasoning of senior dental students. In each clinical case, some important points were embedded that should be considered in clinical decision-making independently and in combination with other factors. The KF is a test based on an individual's clinical reasoning that solves the patient's problem step by step (25).

In the present study, the scores of KF test were at low level and no difference was observed between two genders. the scores of clinical reasoning in Zamani's study were higher than the students' scores in the present study (25). It is worthy to be mentioned that achievement of the clinical educational approach should be applied in dental schools. In the midwifery school, the students experienced an experimental cycle in education. They encountered real situations as a team member and must be manage and make decisions to solve the patient problems. It seems the experimental situation improved the clinical reasoning abilities among midwifery learners. In Zamani's study, the satisfaction of students from KF test was 2.78 ± 0.56 out of 5, which did not differ significantly between strong and weak students (25). In the present study, it was 3.53 ± 0.52 that showed moderate satisfaction which was consistent with the results of the Branch study (26).

In the present study, similar to the study of Arabshahi et al. the Iranian version of the DTI questionnaire was used to assess the clinical reasoning of dental students. The results of the study by Arabshahi et al. showed that the mean score of clinical reasoning of the participants was moderate and diagnostic thinking was not significantly different between residents and interns in terms of components of memory structure and flexibility in thinking. The present results showed the DTI scores of senior dental students were less than that among medical learners in Arabshahi's study. In terms of flexibility in thinking, the results of both studies were close to each other, but the score of memory structure was higher among medical students in the Arabshahi study (18). The result may achieve due to the investigated dental school focused on the improvement of procedural skills of learners more than the thinking abilities such as critical thinking, diagnostic thinking and reasoning skills.

It should be noted that DTI is a test based on participants' self-expression and its subjective nature can affect the results. Tajvidi et al. in 2019 showed there were direct and positive relationship between clinical reasoning and critical thinking in nurses (21). In another study, Rahayu et al. measured clinical reasoning skills in 1135 medical and general practitioners (19). The highest score of clinical reasoning in the study of Rahayu et al. was related to general practitioners (178) and year-4 students (168), respectively (19). In the present study, the scores of dental students were significantly lower than those of Rahayu et al. Rahayu et al mentioned in order for the DTI results to be reliable, it is better to participants have at least 4 years of clinical activity experience, so in the present study, senior dental students were selected (19). In 2015, Sajadi et al. compared the ability of dental students to answer multiple-choice questions and clinical reasoning and calculated their relationship to academic achievement. They concluded that despite good academic achievement, students' ability to answer the clinical reasoning test was low and they gained lower scores compared to multiple-choice tests (27).

In the present study, there was no significant difference in diagnostic thinking between males and females, which was similar to the study of Gehler et al. No significant relationship was reported in the domain of flexibility in thinking. In the study of Gehler et al., there was a significant difference between the two genders in terms of flexibility in thinking, and males scored better than females (28). This result was inconsistent with the results of Tajvidi's study, in which females scored better on clinical reasoning. Diagnostic thinking was poor among dental students in the present study, which was consistent with the results of the study by Tajvidi et al. Also, Tajvidi et al. reported clinical reasoning ability in nursing students and nurses at a moderate level (21) that their participants' scores were higher than students' score in our study. In their study, the reasoning ability of nurses was measured, while in the present study, the reasoning ability of senior dental students who did not have experience of clinical practice and service delivery as a healthcare provider. In addition, the differences of curriculum and clinical education, and the experience of participants may affect on the results. Therefore, it is recommended to conduct further study to assess the influence of experience factor on the development of reasoning skills among dental students and dentists.

Despite obtaining the mean score on the KF test, students' satisfaction about the test was moderate. Existence of structured responses is one of the reasons for increasing learners' satisfaction with this type

of test. Most satisfied with the statement "This test allows me to understand my strengths and weaknesses in the process of diagnosis and management of oral lesions", so it can be said that the use of reasoning tests by providing immediate feedback and objective structured answers can be effective and provide better learning opportunities for students. In addition, in the present study, a face-to-face feedback session was held to improve the educational impact of the test. Due to the low level of clinical reasoning among the participants of the present study, similar to other studies in X context, the planning for teaching and evaluating clinical reasoning in a codified way in different departments of dental schools is necessary.

One of the limitations of the present study was the small number of participants in the investigated dental school. In addition, the complexity of understanding the questions of the DTI took a lot of time for the test takers to complete the questionnaire, which can be effective in answering the final questions of the questionnaire.

Conclusion

Based on the results of the present study, clinical reasoning and diagnostic thinking skills were relatively low among dental students. This issue emphasizes the need for training to enhance diagnostic thinking and reasoning capabilities in dental education. In order to improve this skill in dental students, there is a need to reform the educational programs of this course. It is recommended that clinical reasoning tests be considered formatively to assess the clinical skills of these students.

Declarations

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Authors' contributions:

F.O. & F.K. conceptualized and designed the study. F.O. & M.K. & F.R.M. collected the data. F.K. analyzed the data. F.O. and F.K. wrote the main manuscript text. All authors have met criteria for authorship and had a role in preparing the manuscript. Also, all authors approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Committee of Ethics in Human Research at X. (IR.SSU.REC.1399.302). In this study, an informed consent was obtained from the participants. Eligible participants were informed about the aim of the study, the method, and confidentiality of their responses by e-mail. All methods were performed in accordance with the relevant guidelines and regulations by the ethical certification. (IR.SSU.REC.1399.302).

Consent for publication

Not Applicable.

Competing interests

The authors declare that they have no competing interests.

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