

BMJ Open Attitudes towards and use of dental dams by final-year dental students in Chongqing, China: a cross-sectional study

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ABSTRACT

Objectives To investigate the current and intended future use of dental dams (DDs) and attitudes regarding DD use among final-year dental students at two levels (undergraduate and college) in dental schools in Chongqing, China.

Design A cross-sectional study based on a questionnaire was conducted from June to July 2021.

Setting Chongqing Medical University (CQMU, undergraduate level) and Chongqing Three Gorges Medical College (CQTGMC, junior college level).

Participants A total of 245 final-year dental students.

Main outcome measures An anonymous online questionnaire was distributed to dental students less than 1 month before graduation. Students were asked about the DD training they had received, their attitudes towards some aspects of DDs, their current DD use and their intended future DD use in adult or child patients and in various dental procedures.

Results A total of 238 valid questionnaires were returned (response rate=97.1%, CQMU=96.2%, n=76; CQTGMC=97.6%, n=162). A total of 47.5% of respondents used DDs on real patients during their internships (CQMU=59.2%, CQTGMC=42.0%, $p<0.05$). Whether in restorative procedures or endodontic treatment, the most common reason for not using DDs was a 'lack of knowledge and experience', followed by 'DDs could not be provided by internship institutions'. Although the advantages of DDs were recognised by most students from the two schools, 52.9% thought DDs were difficult to apply (CQMU=42.1%, CQTGMC=58.0%, $p<0.05$). A total of 92.1% of CQMU respondents and 95.1% of CQTGMC respondents expressed their willingness to use DDs after independent practice in the future.

Conclusions Although final-year students have a clear awareness of the advantages of DDs and are very enthusiastic about future DD use, the current DD utilisation rate is low. Education about DDs should be continuously improved in many aspects, and the advantages of using DDs in clinical dentistry should be further emphasised at dental schools.

INTRODUCTION

Dental dams (DDs) have long been considered an established adjunct in operative dentistry procedures and endodontic treatment. They have been used for more than 100 years to control the oral environment.¹

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This was a cross-sectional study and was one of the few studies concerning the use of and attitudes towards dental dams by Chinese dental interns.
- ⇒ Our study selected school students as subjects and investigated them with an anonymous questionnaire, which ensured the authenticity of the results to a certain extent.
- ⇒ Some results may be biased because data points come from self-report questionnaires rather than direct observation of students' learning and clinical operations.
- ⇒ Interns may share attitudes and views, and this tendency for consensus may bias the survey results.

DDs can isolate teeth from any obstacles, such as saliva, tongue, and buccal mucosa, that may interfere with an operation, thus creating a separate, surgically clean operating field and reducing the risk of potential infection transfer.² Moreover, the risk of swallowing or inhaling instruments and medicaments is minimised, and clinical dentists are protected from prosecution due to the patient swallowing or inhaling something during a procedure.³ Improved patient comfort is another advantage of DDs. Previous studies have shown that patients generally have a positive attitude towards DD experiences.^{4 5} In view of the above advantages, many authorities recommend that DDs be routinely used to isolate teeth undergoing endodontic treatment.^{6–8}

In recent years, the application of DD technology has become increasingly widespread, but the prevalence of DD use in various countries is still uneven. According to a survey on the use of DDs by general dentists in the USA, 58% of respondents indicated that they always use the technology.⁹ Another study from the USA surveyed 1490 general practitioners, 47% of whom reported that they always used DDs in root canal treatment.¹⁰ A total of 1085 Indian endodontists were investigated by Kohli *et al.*¹¹ The results showed that the use

Table 1 The students' views on the DD training received and the self-assessment of the training effect

	Total	CQMU	CQTGMC	P value
Please select the form of DD training you have received				
Listening to theoretical lectures in the school classroom	238 (100.0)	76 (100.0)	162 (100.0)	–
Listening to small lectures or other forms of theoretical training in internship institutions	66 (27.7)	21 (27.6)	45 (27.8)	0.981 ^C
Watching video, animation and other multimedia teaching resources	173 (72.7)	63 (82.9)	110 (67.9)	0.016 ^{*C}
Watching a teacher's demonstration on the tooth model	107 (45.0)	42 (55.3)	65 (40.1)	0.029 ^{*C}
Watching a teacher's demonstration on simulated patients	25 (10.5)	14 (18.4)	11 (6.8)	0.006 ^{*C}
Watching a teacher's demonstration on a real patient during the internship	117 (49.2)	45 (59.2)	72 (44.4)	0.034 ^{*C}
Practicing on a tooth model	70 (29.4)	37 (48.7)	33 (20.4)	0.000 ^{*C}
Practicing on simulated patients	21 (8.8)	5 (6.6)	16 (9.9)	0.403 ^C
Practicing real patients during the internship	113 (47.5)	45 (59.2)	68 (42.0)	0.013 ^{*C}
Please choose the DD training you are satisfied with				
Theoretical teaching	214 (89.9)	72 (94.7)	142 (87.7)	0.091 ^C
Watching multimedia resources	161 (67.6)	60 (78.9)	101 (62.3)	0.011 ^{*C}
Watching teacher demonstrations	101 (42.4)	46 (60.5)	55 (34.0)	0.000 ^{*C}
Simulation exercises	59 (24.8)	25 (32.9)	34 (21.0)	0.047 ^{*C}
Clinical practice	58 (24.4)	26 (34.2)	32 (19.8)	0.015 ^{*C}
Please assess your current mastery of DD technology				
Level 0	60 (25.2)	11 (14.5)	49 (30.2)	0.036 ^{*C}
Level 1	112 (47.1)	41 (53.9)	71 (43.8)	
Level 2	49 (20.6)	20 (26.3)	29 (17.9)	
Level 3	17 (7.1)	4 (5.3)	13 (8.0)	
Do you think you have received adequate DD training in dental school				
Yes	47 (19.7)	22 (28.9)	25 (15.4)	0.015 ^{*C}
No	191 (80.3)	54 (71.1)	137 (84.6)	
Please select the areas where you would like to receive further training on DD				
Theoretical teaching	78 (33.8)	26 (34.2)	52 (33.5)	0.920 ^C
Watching multimedia resources	142 (61.5)	43 (56.6)	99 (63.9)	0.285 ^C
Watching teacher demonstrations	144 (62.3)	51 (67.1)	93 (60.0)	0.295 ^C
Simulation exercises	165 (71.4)	50 (65.8)	115 (74.2)	0.184 ^C
Clinical practice	159 (68.8)	49 (64.5)	110 (71.0)	0.317 ^C
I do not need further training	7 (2.9)	0 (0.0)	7 (4.3)	0.100 ^F

*P<0.05.

C, p value from χ^2 test; CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; DD, dental dam; F, p value from Fisher's exact Test.

rate of DDs was 50.5%. Additionally, Raoof *et al*¹² found that the DD usage rate in root canal treatment among general dental practitioners in Iran was 16.5%.

There are many factors leading to the underuse of DDs among dental practitioners, including patient refusal, high cost, time consumption and difficulty in application.^{1 13 14} Another important reason for the suboptimal use of DDs is that dentists do not receive systematic education and professional training regarding DDs.^{1 14 15} The primary task of contemporary dental education is to train dentists who can implement safe and high-quality

treatment.¹⁶ Before working independently, dental students should master the use of DDs and establish that DD use is safe and offers the ability to provide high-quality service. These advantages are of great help in cultivating good clinical diagnosis and treatment habits and improving the utilisation rate of DDs in future clinical work.

However, there is a lack of investigation of the use of DDs by Chinese dental students. Since dental students are future dentists, investigating their use and attitudes towards DDs in schools will help identify potential

Table 2 The classification of internship institutions

	Please select the type of internship institution you worked in during your last year of internship, N (%)			Please select the type of internship institution where you receive DD clinical training, N (%)				
	Total (N=238)	CQMU (N=76)	CQTGMC (N=162)	P value	Total (N=136)	CQMU (N=56)	CQTGMC (N=80)	P value
Public stomatological hospital	84 (35.3)	75 (98.7)	9 (5.6)	0.000 ^{*C}	61 (44.9)	56 (100.0)	5 (6.3)	0.000 ^{*C}
Stomatological department of public general hospital	124 (52.1)	1 (1.3)	123 (75.9)		62 (45.6)	0 (0.0)	62 (77.5)	
Private clinic	30 (12.6)	0 (0.0)	30 (18.5)		13 (9.6)	0 (0.0)	13 (16.3)	

^{*P}<0.05.

C, p value from χ^2 test; CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; DD, dental dam.

^{*}P<0.05.

C, p value from χ^2 test; CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; DD, dental dam.

problems related to the implementation of this world-renowned method and further predict general practice trends in this field.² This approach has been considered in similar studies many times.^{2 16–19}

The purpose of this study is to investigate students' current use of DDs, their attitudes towards DDs, and their intended future use of DDs among final-year dental students at two levels (undergraduate level and junior college level) in dental schools in Chongqing, China.

MATERIALS AND METHODS

This cross-sectional study, based on a questionnaire survey, was conducted in Chongqing, China, from June to July 2021. In Chongqing, only Chongqing Medical University (CQMU) and Chongqing Three Gorges Medical College (CQTGMC) have stomatology as a major and have trained graduates. The stomatology major of CQMU is at the undergraduate level (5-year degree programme), while that of CQTGMC is at the junior college level (3-year degree programme). In the first 4 (CQMU) or 2 years (CQTGMC), students receive theoretical teaching and laboratory simulation practice in the school, and in the last year, they receive clinical training in an internship institution. Our study investigated final-year dental students who graduated from these two schools in 2021. The complete list of classes was obtained from these schools. There were 79 students from CQMU and 166 from CQTGMC. Participation in the survey was voluntary, and all students had the opportunity to refuse participation when the questionnaire was distributed.

The survey was administered as an anonymous network questionnaire. First, we extensively reviewed the literature^{2 16–25} on the questionnaire survey of the clinical use of DDs and dental workers' attitudes towards DDs and screened for question items suitable for the domestic dental education model and may be related to the purpose of our research from these studies. Then, we conducted a face-to-face interview with five dental interns to understand their use of DDs, the DD training they received and their understanding of DDs. Finally, combined with the researcher's many years of experience teaching dental students, an initial questionnaire containing 49 items was compiled. Four experts in relevant fields (including two dental educators and two endodontic specialists, all with senior professional titles) were invited to evaluate the structure of the questionnaire and the correlation between each item and the content to be investigated. According to the expert discussion and opinion, some inappropriate items were deleted, items with repeated sentences and connotations were merged, and the expressions of some items were modified and adjusted. Based on the content validity evaluation of the expert group, a questionnaire with 43 items was designed, inquiring about various aspects of DD use. A pilot study was conducted on a random sample of students (n=20) to ensure that the questions were not difficult to understand and that no changes needed. A copy of the full questionnaire can be

Table 3 The classification of clinical instructors

	Please select the types of clinical instructor(s) who has instructed you, N (%)				Please select the type of clinical instructor(s) who instructed you to use DDs during your internship, N (%)			
	Total (N=238)	CQMU (N=76)	CQTGMC (N=162)	P value	Total (N=136)	CQMU (N=56)	CQTGMC (N=80)	P value
Endodontic specialist	106 (44.5)	76 (100.0)	30 (18.5)	0.000 ^{*C}	68 (50.0)	53 (94.6)	15 (18.8)	0.000 ^{*C}
General dental practitioner	147 (61.8)	2 (2.6)	145 (89.5)	0.000 ^{*C}	66 (48.5)	1 (1.8)	65 (81.3)	0.000 ^{*C}
Nonendodontic specialist	118 (49.6)	76 (100.0)	42 (25.9)	0.000 ^{*C}	9 (6.6)	3 (5.4)	6 (7.5)	0.736 ^F

*P<0.05.

C, p value from χ^2 test; CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; DD, dental dam; F, p value from Fisher's exact test.

found in online supplemental file 1. The main contents were as follows:

- ▶ Personal information of the respondents, such as sex, age and name of dental school.
- ▶ The DD training received by students and their views on it, as well as the self-assessment of the training effect. In this study, students' proficiency with DD application is divided into four levels.²⁵ Level 0 means they basically do not have knowledge of DDs; level 1 means they have some knowledge but have no practical experience; level 2 means they have some knowledge and have handled simple cases but cannot handle complex cases and level 3 means they have fully mastered DD application and can handle any situation.
- ▶ Information relating to intracoronar restorations and root canal treatment during the internship and the application of DDs in these procedures.
- ▶ Students' attitudes towards some aspects of DDs.
- ▶ Intended future use of DDs during independent practice.

Trained and qualified dental professionals acted as investigators. One month before graduation, all students of the two schools were sent an informed consent document and a link to an online questionnaire. If they agreed to participate in the survey, they could access the questionnaire page through the link provided. If the students encountered any problems when completing the questionnaire, they could contact the investigator at any time for help. To measure the test-retest reliability of the questionnaire, 20 students who returned the questionnaire the first time were selected to complete the questionnaire again 2 weeks after the first survey. The consistency of the two questionnaires was determined by the kappa value, which was greater than 0.9.

If there were missing or incorrectly completed items in a questionnaire, the questionnaire was excluded. After manual verification, the collected data were double-entered. SPSS software (V.20, SPSS) was used for statistical analysis. Frequencies/percentages and means/SDs are shown to describe categorical and continuous variables, respectively, and the χ^2 test or Fisher's exact test

was used to compare categorical variables. A $p<0.05$ was considered statistically significant.

Patient and public involvement

Some selected students were involved in the development and validation of the questionnaire. In face-to-face interviews or pilot studies, they had the opportunity to provide feedback on the content and wording of the questionnaire. The information they provided was used to develop and revise the questionnaire. Students were not involved in the design, recruitment or conduct of the study.

RESULTS

A total of 245 questionnaires were distributed, and 238 questionnaires were returned. All of the returned questionnaires were valid. Finally, 76 CQMU students (23 males and 53 females with an average age of 23.2 ± 0.61 years) and 162 CQTGMC students (47 males and 115 females with an average age of 21.53 ± 0.80 years) were included in this study.

The students' views on the DD training received and the self-assessment of the training effect are reported in table 1. Generally, all respondents listened to theoretical courses in the school classroom, but few watched a teacher's demonstration or practised DD themselves, which was more significant among junior college students ($p<0.05$). A total of 47.5% of the respondents used DDs on real patients during their internships (CQMU=59.2%, CQTGMC=42.0%, $p<0.05$). The respondents were most satisfied with the theoretical teaching they received (89.9%), followed by watching multimedia resources (67.6%), watching teacher demonstrations (42.4%), simulation exercises (24.8%), and clinical practice (24.4%). In the self-assessment of the mastery of DD technology, 25.2% of the respondents rated it as 'level 0', 47.1% as 'level 1', 20.6% as 'level 2' and only 7.1% as 'level 3'. Only 19.7% of the respondents claimed that they had received adequate education during their dental school studies. A total of 97.1% of the respondents were willing to receive further training on DD use in the following areas: theoretical teaching (33.8%), watching

Table 4 DD use in adult/paediatric patients and in various clinical procedures

	Mandatory usage of DD, N (%)		Actual application frequency of DD, N (%)				I have never done this before		
	Mandatory	Optional	Always (100%)	Mostly (76%–99%)	Often (51%–75%)	Occasionally (26%–50%)	Rarely (1%–25%)	Never (0%)	
Adult patients									
CQMU	0 (0.0)	76 (100.0)	0 (0.0)	6 (7.9)	12 (15.8)	9 (11.8)	18 (23.7)	31 (40.8)	0
CQTGMC	0 (0.0)	162 (100.0)	0 (0.0)	5 (3.1)	8 (4.9)	19 (11.7)	36 (22.2)	94 (58.0)	0
Child patients									
CQMU	0 (0.0)	53 (100.0)	0 (0.0)	2 (3.8)	4 (7.5)	3 (5.7)	6 (11.3)	38 (71.7)	23
CQTGMC	0 (0.0)	157 (100.0)	0 (0.0)	3 (1.9)	5 (3.2)	10 (6.4)	22 (14.0)	117 (74.5)	5
Anterior composites									
CQMU	0 (0.0)	71 (100.0)	0 (0.0)	3 (4.2)	3 (4.2)	5 (7.0)	8 (11.3)	52 (73.2)	5
CQTGMC	0 (0.0)	156 (100.0)	0 (0.0)	3 (1.9)	9 (5.8)	9 (5.8)	18 (11.5)	117 (75.0)	6
Anterior glass-ionomer cement									
CQMU	0 (0.0)	60 (100.0)	0 (0.0)	2 (3.3)	4 (6.7)	3 (5.0)	5 (8.3)	46 (76.7)	16
CQTGMC	0 (0.0)	153 (100.0)	0 (0.0)	2 (1.3)	6 (3.9)	7 (4.6)	16 (10.5)	122 (79.7)	9
Posterior composites									
CQMU	0 (0.0)	74 (100.0)	0 (0.0)	3 (4.1)	5 (6.8)	9 (12.2)	18 (24.3)	39 (52.7)	2
CQTGMC	0 (0.0)	159 (100.0)	0 (0.0)	6 (3.8)	12 (7.5)	12 (7.5)	26 (16.4)	103 (64.8)	3
Posterior glass-ionomer cement									
CQMU	0 (0.0)	64 (100.0)	0 (0.0)	1 (1.6)	5 (7.8)	6 (9.4)	14 (21.9)	38 (59.4)	12
CQTGMC	0 (0.0)	152 (100.0)	0 (0.0)	4 (2.6)	6 (3.9)	9 (5.9)	17 (11.2)	116 (76.3)	10
Posterior amalgams									
CQMU	0 (0.0)	33 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (9.1)	5 (15.2)	25 (75.8)	43
CQTGMC	0 (0.0)	107 (100.0)	0 (0.0)	1 (0.9)	1 (0.9)	6 (5.6)	14 (13.1)	85 (79.4)	55
Root canal treatment of anterior teeth									
CQMU	0 (0.0)	66 (100.0)	1 (1.5)	4 (6.1)	5 (7.6)	1 (1.5)	2 (3.0)	53 (80.3)	10
CQTGMC	0 (0.0)	162 (100.0)	0 (0.0)	3 (1.9)	8 (4.9)	14 (8.6)	24 (14.8)	113 (69.8)	0
Root canal treatment of premolar teeth									
CQMU	2 (3.2)	61 (96.8)	2 (3.2)	3 (4.8)	7 (11.1)	4 (6.3)	8 (12.7)	39 (61.9)	13
CQTGMC	0 (0.0)	161 (100.0)	0 (0.0)	5 (3.1)	6 (3.7)	14 (8.7)	25 (15.5)	111 (68.9)	1
Root canal treatment of molar teeth									
CQMU	3 (4.9)	58 (95.1)	3 (4.9)	6 (9.8)	10 (16.4)	4 (6.6)	7 (11.5)	31 (50.8)	15
CQTGMC	0 (0.0)	154 (100.0)	0 (0.0)	7 (4.5)	13 (8.4)	14 (9.1)	26 (16.9)	94 (61.0)	8
CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; DD, dental dam.									

multimedia resources (61.5%), watching teacher demonstrations (62.3%), simulation exercises (71.4%) and clinical practice (68.8%).

The classification of the internship institutions and clinical instructors of students are shown in tables 2 and 3, respectively. A total of 57.1% (136/238) of the respondents reported that they had received clinical training in DD during their internships. Furthermore, the proportions of respondents who received DD training in public stomatological hospitals, stomatology departments of public general hospitals and private clinics were 72.6% (61/84), 50.0% (62/124) and 43.3% (13/30), respectively. In addition, 106 respondents were instructed by endodontic specialists, of which 64.2% (68/106) received DD training from endodontic specialists. In total, 44.9% (66/147) and 7.6% (9/118) of the respondents were instructed by general dental practitioners and non-endodontic specialists, respectively.

The mandatory usage and actual application of DDs reported by the respondents in adult/paediatric patients and in clinical procedures is shown in table 4. All the respondents treated adult patients, and 47.4% used DDs in adult patients. A total of 210 respondents treated paediatric patients, of whom 26.2% used DDs in paediatric patients. DDs are not mandatory for either adult or paediatric patients. There were 227, 213, 233, 216 and 140 respondents who had performed composite restoration on anterior teeth, glass-ionomer restoration on anterior teeth, composite restoration on posterior teeth, glass-ionomer cement restoration on posterior teeth and amalgam restoration on posterior teeth, respectively. The DD use rates in these procedures were 25.6% (58/227), 21.1% (45/213), 39.1% (91/233), 28.7% (62/216) and 21.4% (30/140), respectively. DDs are not mandatory for the above restorative procedures. There were 228, 224 and 215 respondents who had performed root canal treatment on anterior teeth, premolars and molars, respectively. In these procedures, the DD use rates were 27.2% (62/228), 33.0% (74/224) and 41.9% (90/215), and the compulsory utilisation rates of DD were only 0% (0/228), 0.9% (2/224) and 1.4% (3/215).

A total of 145 and 141 respondents had never used DDs in restorative procedures or endodontic treatment during their internships, respectively. The reasons for not using DDs are shown in table 5. Among these two groups, the most common reason was 'I lack knowledge and experience' ('never used in restorative procedures' group=69.0%, 'never used in endodontic treatment' group=73.0%), and more respondents from CQTGMC believed that 'DDs are not provided by internship institutions' than students from CQMU ($p<0.05$). In the 'never used in restorative procedures' group, more respondents from CQTGMC thought that DD was not necessary than those from CQMU ($p<0.05$), but there was no such difference in the 'never used in endodontic treatment' group ($p>0.05$).

The respondents were asked to agree or disagree with some aspects of DDs. The statements and their responses

Table 5 The reasons students did not use DDs

	Never used in restorative procedures, N (%)			Never used in endodontic treatment, N (%)		
	Total (N=145)	CQMU (N=39)	CQTGMC (N=106)	Total (N=141)	CQMU (N=46)	CQTGMC (N=95)
DDs are considered to have disadvantages (such as time-consuming, inconvenient, etc)	33 (22.8)	8 (20.5)	25 (23.6)	38 (27.0)	14 (30.4)	24 (25.3)
I lack knowledge and experience	100 (69.0)	23 (59.0)	77 (72.6)	103 (73.0)	33 (71.7)	70 (73.7)
I do not think they are necessary	38 (26.2)	4 (10.3)	34 (32.1)	18 (12.8)	4 (8.7)	14 (14.7)
DDs are not provided by internship institutions	42 (29.0)	3 (7.7)	39 (36.8)	42 (29.8)	3 (6.5)	39 (41.1)
Patients were unwilling or refused to use DDs	27 (18.6)	7 (17.9)	20 (18.9)	26 (18.4)	10 (21.7)	16 (16.8)
Other reasons	4 (2.8)	1 (2.6)	3 (2.8)	4 (2.8)	1 (2.2)	3 (3.2)
* $P<0.05$.						
C, p value from χ^2 test; CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; DD, dental dam; F, p value from Fisher's exact test.						

are reported in table 6. Most of the respondents claimed that DDs allowed clearer access to the operating site (97.1%), reduced the incidence of swallowing or inhaling (99.6%), and enabled a higher clinical standard to be achieved (91.2%). At the same time, the respondents agreed that adequate isolation cannot be achieved if a DD is not used (79.0%) and that restorations placed while using a DD have greater longevity than those placed without the use of a DD (86.1%). On the other hand, more than half of the respondents expressed the opinion that DDs are difficult to apply (total=52.9%, CQMU=42.1%, CQTGMC=58.0%, $p<0.05$). Additionally, 60.5% of the respondents stated that patients do not like DDs, with CQTGMC having more respondents who expressed this opinion than CQMU (66.0% vs 48.7%, $p<0.05$).

The opinions of students about the intended future usage of DDs are shown in table 7, with 92.1% of the CQMU respondents and 95.1% of the CQTGMC respondents indicating that they would like to use DDs in their private practices. Among them, 44.2% (99/224) were willing to use DDs in adults, 1.3% (3/224) were willing to use DDs in children and 54.5% (122/224) were willing to use DDs in both adults and children. A total of 12.5% (28/224) of the respondents said they would use DDs only for endodontic treatment, 12.1% (27/224) indicated that they would use DDs for restorative procedures, and 75.4% (169/224) reported that they would use DDs for all procedures indicated.

DISCUSSION

DDs can effectively protect both doctors and patients, fully reflect the preferred treatment strategies and professional level of dentists, and improve patients' treatment experiences.³ In dental school education, especially with respect to clinical practice tactics, it is very important to train students so that they have theoretical knowledge and operative skills regarding DD application. This training would not only affect the clinical utilisation rate and operation level of DDs but also influence young dentists' planning and choices in their future work. This study investigated the current use of DDs, attitudes towards DDs, and intended future use of DDs among final-year dental students. As the DD trainings received by students from CQMU and CQTGMC were quite different, the relevant results are reported by school to reflect the situation more accurately.

A survey on the topic found that it is easier for respondents to report what they think is the right answer rather than the real answer.^{9 17} However, in this study, the respondents were all school students, and they were more likely to express their true thoughts than doctors who were under the pressure of a challenging environment. In addition, an anonymous survey was adopted, and the answers given by the respondents were effectively kept anonymous, which also ensured the authenticity of the survey results to a certain extent. On the other hand, this study does have some limitations, mainly because it relies

on the information provided by a questionnaire rather than direct observation of students' learning and clinical operations. Some students may not be able to accurately recall their DD training experiences, especially those with in-school training, which may lead to recall bias. In addition, some interns may practice and live in the same place. They are more likely to interact and share attitudes and views. This tendency of consensus may have introduced deviations into the survey results.

In our study, 59.2% of the CQMU respondents and 42.0% of the CQTGMC respondents had applied DDs to adult patients, which was lower than the rate reported in similar international surveys.^{2 16 17} Mala *et al*² surveyed 87 British and Irish students and found that 99% of respondents used DDs in adult patients. Other data from Saudi Arabia showed that all 294 of their respondents had used DDs in adult patients.¹⁷ According to Tanalp *et al*,¹⁶ there are two dental schools in Turkey where DDs are mandatory for endodontic treatment. Therefore, considering the advantages of DDs, extensive and routine DD applications should be emphasised in the two schools we investigated. In fact, the relevant policies in the field of dental education have improved at the national level. According to the revised examination syllabus for stomatological practitioners in 2018, DD technology was listed as a practical skill examination item.²⁶ This improvement is conducive to promoting education and training related to DDs. More detailed teaching plans should be developed by Chinese dental schools to cultivate qualified students who meet the national standards.

The main reasons the students did not use DDs were 'I lack knowledge and experience' and 'DDs are not provided by internship institutions'. In China, the DD utilisation rate in general clinical practice is lower than that in other developed countries,²⁵ and dental schools usually do not require students to use DDs in practice.³ In this study, a few students reported that their clinical instructors had taught them to use DDs and were required to mandate DD use during the internship. According to Zou *et al*,²⁵ the nonuse of DDs by dentists is a result of being taught by trainers who could not or did not use them. It is important that dental educators consistently use DDs and train their students to use them. Therefore, it is the responsibility of dental schools and clinical instructors to provide students with opportunities and materials other than classroom teaching to master the use of DD.¹⁸

The advantages of DDs, such as full isolation of the operation area, reduced inhalation and swallowing of instruments, and facilitation of a higher clinical standard, are generally recognised by students. On the other hand, approximately half of the students thought that DD use was difficult and time-consuming. More than 20% of the students did not use DDs because they did not want to spend time on an application that is difficult for them. Previous studies^{13 14} have shown that these factors also limit dentists' use of DDs. Although there are many other

Table 6 Agreement or disagreement of students regarding various aspects of DDS

Do you agree with the following statement?	Agree, N (%)		Disagree, N (%)		P value
	CQMU	Cqtgmc	CQMU	Cqtgmc	
Adequate isolation cannot be achieved if a DD is not used	61 (80.3)	127 (78.4)	15 (19.7)	35 (21.6)	0.742 ^C
DDs enable clearer access to the operating site	73 (96.1)	158 (97.5)	3 (3.9)	4 (2.5)	0.683 ^F
The difficulty of the restoration phase will be reduced once a DD is used	73 (96.1)	146 (90.1)	3 (3.9)	16 (9.9)	0.116 ^C
The use of a DD can reduce the incidence of swallowing or inhaling	76 (100.0)	161 (99.4)	0 (0.0)	1 (0.6)	1.000 ^F
DD placement should be compulsory before endodontic treatment	34 (44.7)	89 (54.9)	42 (55.3)	73 (45.1)	0.142 ^C
DDs are difficult to apply	32 (42.1)	94 (58.0)	44 (57.9)	68 (42.0)	0.022 ^C
DDs enable a higher clinical standard to be achieved	68 (89.5)	149 (92.0)	8 (10.5)	13 (8.0)	0.526 ^C
Restorations placed while using a DD have greater longevity than those placed without the use of a DD	65 (85.5)	140 (86.4)	11 (14.5)	22 (13.6)	0.852 ^C
DDs increase the difficulty of intraoperative radiography	55 (72.4)	103 (63.6)	21 (27.6)	59 (36.4)	0.181 ^C
Assistance is necessary during DD application	68 (89.5)	154 (95.1)	8 (10.5)	8 (4.9)	0.108 ^C
Patients do not like to use DDs	37 (48.7)	107 (66.0)	39 (51.3)	55 (34.0)	0.011 ^C
DD application is time-consuming and reduces work efficiency	36 (47.4)	87 (53.7)	40 (52.6)	75 (46.3)	0.362 ^C
Before using a DD, the patient should be asked about their history of latex allergies	76 (100.0)	155 (95.7)	0 (0.0)	7 (4.3)	0.100 ^F

*P value<0.05.

C, p value from χ^2 test; CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; F, p value from Fisher's exact test.

Table 7 Opinion of students about the intended future usage of DDS

When working independently in the future, I intend to use DDS	Total (N=224)	Cqmu (N=70)	Cqtgmc (N=154)	P value
In adult or child patients				
In both adults and children	122 (54.5)	33 (47.1)	89 (57.8)	0.015 ^F
Only in adults	99 (44.2)	34 (48.6)	65 (42.2)	
Only in children	3 (1.3)	3 (4.3)	0 (0.0)	
During restorative procedures or endodontic treatment				
During all procedures indicated	169 (75.4)	48 (68.6)	121 (78.6)	0.245 ^C
Only during restorative procedures	27 (12.1)	10 (14.3)	17 (11.0)	
Only during endodontic treatment	28 (12.5)	12 (17.1)	16 (10.4)	

*P<0.05.

C, p value from χ^2 test; CQMU, Chongqing Medical University; CQTGMC, Chongqing Three Gorges Medical College; F, p value from Fisher's exact test.

isolation methods (cotton roll, saliva evacuators, etc), none can exceed the safety and effectiveness provided by DDS.^{9 10} The effectiveness of technology improves with experience.⁹ Therefore, in dental education, it may be necessary to emphasise DD operational skills to improve students' operational proficiency and reduce their negative views of DDS.²

In the two schools investigated, although most students received theoretical teaching on DDS, the proportion of students who watched teachers' demonstrations and practiced using DDS has decreased significantly. Students were less satisfied with the simulation exercises and clinical practice on the use of DDS, and most of the respondents were willing to receive further DD training. These findings highlight the problem in merely talking about stratagems on paper when teaching DD use in the school curriculum, which may lead students to know that only DDS should be applied but not know how to apply them. Therefore, as proposed by SAH *et al*,²¹ preclinical simulation exercises and clinical hands-on practice should be increased, since the ability to successfully place DDS in a variety of clinical situations requires practice and clinical experience that cannot otherwise be taught.

In this study, 92.1% of the CQMU respondents and 95.1% of the CQTGMC respondents indicated that they would like to use DDS when working independently in the future. However, surveys of dentists in independent practice have shown that the utilisation rate of DDS is not high.^{15 20 25 27} Students who are educated through contemporary educational methods are exposed to the latest treatment concepts and are more likely to practice the isolation methods taught by dental schools after graduation.²⁵ Pertinently, previous studies have shown that DD use is greater in newly qualified graduates than in older practitioners.^{28 29} However, Jenkins *et al*³⁰ came to the opposite conclusion, showing that older practitioners are more likely to use DDS than their younger counterparts. Dentists with additional training may be more likely to use DDS.²⁵ These findings suggest that the role of education in the promotion of the clinical application of DDS should not be ignored.

Within the sample examined, DDS were mainly used in endodontic treatment. In addition, nearly 90% of the students indicated that they would like to use DDS in endodontic treatment in the future. Although DDS are usually the first choice in root canal procedures, their role in other procedures should not be ignored. The present research mainly focuses on the application of DDS in endodontics.³¹ At the same time, dental education emphasises that DDS are an important part of endodontics, and their effectiveness in other procedures is rarely mentioned.¹⁶ These factors may lead students to believe that DDS and endodontic treatment are interrelated. In this study, 44.7% of the CQMU students and 54.9% of the CQTGMC students reported that DD placement before endodontic treatment is compulsory.

The samples included in this study seem to be highly representative because they came from two dental schools in Chongqing, and the rate of lost to follow-up was very low. Local dental instructors and educational decision-makers could benefit from our study. However, the present findings are limited to the city of Chongqing. Future studies with a broad inclusion of interns and dental schools are recommended, as they would be more representative of the population of Chinese dental students.

CONCLUSION

Overall, although final-year students are aware of the advantages of DDS, they are still not comfortable with the use of DDS, creating uncertainty about the future integration of this tool in routine practice. In addition, there may be a lack of hands-on training for students in the teaching of DD use in school curricula, and there is room to enhance the education on DD use. In view of the important role of education in promoting the clinical application of DD, dental schools have a responsibility to continuously improve their teaching measures and emphasise the advantages of using DDS during an internship to cultivate competent future dentists.

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Patient consent for publication Informed consent from all participants was obtained by the investigator.

Ethics approval Ethical approval was obtained from the ethics committee of the College of Stomatology, Chongqing Medical University (#2021-022) and the Ethics Committee of Chongqing Three Gorges Medical College (#20210518). Participants gave informed consent to participate in the study before taking part.

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Questionnaire on attitudes toward and use of dental dams among final-year dental students in Chongqing

1. The name of the university you attended or graduated from: [Single choice questions]

- ☐ Chongqing Medical University
- ☐ Chongqing Three Gorges Medical College

2. Your gender: [Single choice questions]

- ☐ Male
- ☐ Female

3. Your age: [Fill-in-the-blanks test]

4. Please select the form of dental dam training you have received: [Multiple choice questions]

- ☐ Listening to theoretical lectures in the school classroom
- ☐ Listening to small lectures or other forms of theoretical training in internship institutions
- ☐ Watching video, animation and other multimedia teaching resources
- ☐ Watching a teacher's demonstration on the tooth model
- ☐ Watching a teacher's demonstration on simulated patients
- ☐ Watching a teacher's demonstration on a real patient during the internship
- ☐ Practicing on a tooth model
- ☐ Practicing on simulated patients
- ☐ Practicing real patients during the internship

5. Please choose the dental dam training you are satisfied with: [Multiple choice questions]

- ☐ Theoretical teaching
- ☐ Watching multimedia resources
- ☐ Watching teacher demonstrations
- ☐ Simulation exercises
- ☐ Clinical practice

6. Please assess your current mastery of dental dam technology: [Single choice questions]

- ☐ I basically do not have knowledge of dental dams. (Level 0)
- ☐ I have some knowledge but have no practical experience. (Level 1)
- ☐ I have some knowledge and have handled simple cases but cannot handle complex cases. (Level 2)
- ☐ I have fully mastered the dental dam application and can handle any situation. (Level 3)

7. Do you think you have received adequate dental dam training in dental school? [Single choice questions]

- ☐ Yes
- ☐ No

8. Are you willing to receive further training in the use of dental dams? [Single choice questions]

(If “no” is selected, Q9 does not need to be answered)

☐Yes ☐No

9. Please select the areas where you would like to receive further training on dental dam use: [Multiple choice questions]

- ☐Theoretical teaching
- ☐Watching multimedia resources
- ☐Watching teacher demonstrations
- ☐Simulation exercises
- ☐Clinical practice

10. Please select the type of internship institution you worked in during your last year of internship: [Single choice questions]

- ☐Public stomatological hospital
- ☐Stomatological department of public general hospital
- ☐Private clinics

11. Please select the type of clinical instructor(s) who has instructed you: [Multiple choice questions]

- ☐Endodontic specialist
- ☐General dental practitioner
- ☐Nonendodontic specialist

12. In the internship institution, have you received dental dam clinical training? [Single choice questions]

(If “no” is selected, Q13 does not need to be answered)

☐Yes ☐No

13. Please select the type of clinical instructor(s) who instructed you to use the dental dam during your internship: [Multiple choice questions]

- ☐Endodontic specialist
- ☐General dental practitioner
- ☐Nonendodontic specialist

14. Have you ever treated adult patients in your internship? [Single choice questions]

(If “no” is selected, Q14(1) and Q14(2) do not need to be answered.)

☐Yes ☐No

(1) How often do you use dental dams on adult patients? [Single choice questions]

- ☐Always (100%)
- ☐Mostly (76–99%)
- ☐Often (51–75%)
- ☐Occasionally (26–50%)
- ☐Rarely (1–25%)
- ☐Never (0%)

(2) Is the use of dental dams mandatory or optional when you treat adult patients?

[Single choice questions]

☐Mandatory ☐Optional

15. Have you ever treated child patients in your internship? [Single choice questions]
(If “no” is selected, Q15(1) and Q15(2) do not need to be answered.)

☐Yes ☐No

(1) How often do you use dental dams on child patients? [Single choice questions]

☐Always (100%)

☐Mostly (76–99%)

☐Often (51–75%)

☐Occasionally (26–50%)

☐Rarely (1–25%)

☐Never (0%)

(2) Is the use of dental dams mandatory or optional when you treat child patients?
[Single choice questions]

☐Mandatory ☐Optional

16. During your internship, have you ever performed anterior composites? [Single choice questions]

(If “no” is selected, Q16(1) and Q16(2) do not need to be answered.)

☐Yes ☐No

(1) How often do you use the dental dam for anterior composites? [Single choice questions]

☐Always (100%)

☐Mostly (76–99%)

☐Often (51–75%)

☐Occasionally (26–50%)

☐Rarely (1–25%)

☐Never (0%)

(2) Is the use of dental dams mandatory or optional when performing anterior composites? [Single choice questions]

☐Mandatory ☐Optional

17. During your internship, have you ever performed anterior glass-ionomer cement? [Single choice questions]

(If “no” is selected, Q17(1) and Q17(2) do not need to be answered.)

☐Yes ☐No

(1) How often do you use the dental dam for anterior glass-ionomer cement? [Single choice questions]

☐Always (100%)

☐Mostly (76–99%)

☐Often (51–75%)

☐Occasionally (26–50%)

☐Rarely (1–25%)

☐Never (0%)

(2) Is the use of dental dams mandatory or optional when performing anterior glass-ionomer cement? [Single choice questions]

☐Mandatory ☐Optional

18. During your internship, have you ever performed posterior composites? [Single choice questions]

(If “no” is selected, Q18(1) and Q18(2) do not need to be answered)

☐Yes ☐No

(1) How often do you use the dental dam for posterior composites? [Single choice questions]

- ☐Always (100%)
- ☐Mostly (76–99%)
- ☐Often (51–75%)
- ☐Occasionally (26–50%)
- ☐Rarely (1–25%)
- ☐Never (0%)

(2) Is the use of dental dams mandatory or optional when performing posterior composites? [Single choice questions]

☐Mandatory ☐Optional

19. During your internship, have you ever performed posterior glass-ionomer cement? [Single choice questions]

(If “no” is selected, Q19(1) and Q19(2) do not need to be answered.)

☐Yes ☐No

(1) How often do you use the dental dam for posterior glass-ionomer cement? [Single choice questions]

- ☐Always (100%)
- ☐Mostly (76–99%)
- ☐Often (51–75%)
- ☐Occasionally (26–50%)
- ☐Rarely (1–25%)
- ☐Never (0%)

(2) Is the use of dental dams mandatory or optional when performing posterior glass-ionomer cement? [Single choice questions]

☐Mandatory ☐Optional

20. During your internship, have you ever performed posterior amalgams? [Single choice questions]

(If “no” is selected, Q20(1) and Q20(2) do not need to be answered.)

☐Yes ☐No

(1) How often do you use the dental dam for posterior amalgams? [Single choice questions]

- ☐Always (100%)
- ☐Mostly (76–99%)
- ☐Often (51–75%)
- ☐Occasionally (26–50%)
- ☐Rarely (1–25%)
- ☐Never (0%)

(2) Is the use of dental dams mandatory or optional when performing posterior amalgams? [Single choice questions]

☐Mandatory ☐Optional

21. During your internship, have you ever performed root canal treatment of anterior teeth? [Single choice questions]

(If “no” is selected, Q21(1) and Q21(2) do not need to be answered)

☐Yes ☐No

(1) How often do you use the dental dam for root canal treatment of anterior teeth?

[Single choice questions]

- ☐ Always (100%)
- ☐ Mostly (76–99%)
- ☐ Often (51–75%)
- ☐ Occasionally (26–50%)
- ☐ Rarely (1–25%)
- ☐ Never (0%)

(2) Is the use of dental dams mandatory or optional when root canal treatment of anterior teeth is performed? [Single choice questions]

- ☐ Mandatory
- ☐ Optional

22. During your internship, have you ever performed root canal treatment of premolar teeth? [Single choice questions]

(If “no” is selected, Q22(1) and Q22(2) do not need to be answered)

- ☐ Yes
- ☐ No

(1) How often do you use the dental dam for root canal treatment of premolar teeth?

[Single choice questions]

- ☐ Always (100%)
- ☐ Mostly (76–99%)
- ☐ Often (51–75%)
- ☐ Occasionally (26–50%)
- ☐ Rarely (1–25%)
- ☐ Never (0%)

(2) Is the use of dental dams mandatory or optional when root canal treatment of premolar teeth is performed? [Single choice questions]

- ☐ Mandatory
- ☐ Optional

23. During your internship, have you ever performed root canal treatment of molar teeth? [Single choice questions]

(If “no” is selected, Q23(1) and Q23(2) do not need to be answered.)

- ☐ Yes
- ☐ No

(1) How often do you use the dental dam for root canal treatment of molar teeth?

[Single choice questions]

- ☐ Always (100%)
- ☐ Mostly (76–99%)
- ☐ Often (51–75%)
- ☐ Occasionally (26–50%)
- ☐ Rarely (1–25%)
- ☐ Never (0%)

(2) Is the use of dental dams mandatory or optional when root canal treatment of molar teeth is performed? [Single choice questions]

- ☐ Mandatory
- ☐ Optional

24. During your internship, have you used dental dams in restorative procedures?

[Single choice questions]

(If “yes” is selected, Q25 does not need to be answered)

- ☐ Yes
- ☐ No

25. Please select the reason you do not use the dental dam in the restorative procedures: [Multiple choice questions]

- ☐Dental dams are considered to have disadvantages (such as time-consuming, inconvenient, etc.)
- ☐I lack knowledge and experience
- ☐I do not think they are necessary
- ☐Dental dams are not provided by internship institutions
- ☐Patients were unwilling or refused to use dental dams
- ☐Other reasons

26. During your internship, have you used dental dams in endodontic treatment?

[Single choice questions]

(If “yes” is selected, Q27 does not need to be answered)

- ☐Yes ☐No

27. Please select the reason you do not use the dental dam in the endodontic treatment: [Multiple choice questions]

- ☐Dental dams are considered to have disadvantages (such as time-consuming, inconvenient, etc.)
- ☐I lack knowledge and experience
- ☐I do not think they are necessary
- ☐Dental dams are not provided by internship institutions
- ☐Patients were unwilling or refused to use dental dams
- ☐Other reasons

28. Do you agree that adequate isolation cannot be achieved if a dental dam is not used? [Single choice questions]

- ☐Yes ☐No

29. Do you agree that a dental dam enables clearer access to the operating site?

[Single choice questions]

- ☐Yes ☐No

30. Do you agree that the difficulty of the restoration phase is reduced once a dental dam is used? [Single choice questions]

- ☐Yes ☐No

31. Do you agree that the use of a dental dam can reduce the incidence of swallowing or inhaling? [Single choice questions]

- ☐Yes ☐No

32. Do you agree that dental dam placement should be compulsory before endodontic treatment? [Single choice questions]

- ☐Yes ☐No

33. Do you agree that a dental dam is difficult to apply? [Single choice questions]

- ☐Yes ☐No

34. Do you agree that a dental dam enables a higher clinical standard to be achieved?

[Single choice questions]

- ☐Yes ☐No

35. Do you agree that restorations placed while using a dental dam have greater longevity than those placed without the use of a dental dam? [Single choice questions]

☐Yes ☐No

36. Do you agree that a dental dam increases the difficulty of intraoperative radiography? [Single choice questions]

☐Yes ☐No

37. Do you agree that assistance is necessary during dental dam application? [Single choice questions]

☐Yes ☐No

38. Do you agree that patients do not like to use dental dams? [Single choice questions]

☐Yes ☐No

39. Do you agree that dental dam application is time-consuming and reduces work efficiency? [Single choice questions]

☐Yes ☐No

40. Do you agree that before using a dental dam, the patient should be asked about the allergy history of latex materials? [Single choice questions]

☐Yes ☐No

41. Would you like to use a dental dam in your private practices following graduation? [Single choice questions]

(If “I will never use it” is selected, Q42 and Q43 do not need to be answered)

☐I intend to use the dental dam

☐I will never use it

42. In private practice, what kind of patients would you like to use dental dams on? [Single choice questions]

☐Only adults

☐Only children

☐Both adults and children

43. In private practice, for what kind of procedure would you like to use dental dams? [Single choice questions]

☐Only endodontic treatment

☐Only restorative procedures

☐All procedures indicated