Title: Teaching of bridges (fixed partial dentures) in Ireland and United Kingdom dental schools.

Authors: Satnam Singh Virdee

Lecturer/ Honorary StR In Restorative Dentistry

University of Birmingham

Christopher D Lynch

Professor/ Consultant in Restorative Dentistry,

University Dental School & Hospital,

Wilton, Cork,

Ireland.

Leili Sadaghiani

Senior Lecturer/ Consultant in Restorative Dentistry,

School of Dentistry,

Heath Park,

Cardiff.

Liam D Addy

Consultant in Restorative Dentistry

School of Dentistry,

Heath Park,

Cardiff.

Alan SM Gilmour

Professor/ Consultant in Restorative Dentistry,

School of Dentistry,

Heath Park,

Cardiff.

Igor R Blum

Director, King's College Maurice Wohl Dental Centre,
Consultant/Senior Lecturer in Restorative Dentistry

King’s College,

London.

Nairn HF Wilson

Emeritus Professor of Dentistry,

King’s College,

London.

Address for correspondence: Professor Chris Lynch,

University Dental School & Hospital,

Wilton,

Cork,

Ireland.

Email: chris.lynch@ucc.ie

Keywords: fixed bridges

dental school

undergraduate

dental education

missing teeth

impressions

Abstract

Aim: The aim of this study was to investigate and describe the current teaching of bridges (fixed partial dentures) within dental schools in Ireland and the United Kingdom. The authors previously surveyed this teaching in 2009.

Method: Following receipt of positive ethical approval, an online survey was distributed to the 18 dental schools in Ireland and the United Kingdom with primary dental degree programmes in January 2017. This questionnaire sought information about the current nature and extent of dental school teaching of bridges, including clinical techniques taught. Information was also sought on current and future challenges to teaching in this area.

Results: Responses were received from all 18 schools invited to participate (response rate = 100%). There was diversity in the range of exercises completed in preclinical courses for bridgework: greatest commonality was seen in relation to preparation exercises for fixed-fixed posterior conventional bridges (n= 14 schools) and cantilever anterior resin-retained bridges (n=13 schools). Fourteen schools required students to complete a preclinical assessment prior to them being permitted to provide bridgework in a clinical setting. Anterior cantilevered resin retained bridges were the most common clinical treatment provided (average = 1.67 bridges per student per respondent school; range = 0 – 3), representing a two-fold increase since the 2009 survey, which indicated that the equivalent mean was 0.83 per student. Two schools permitted their students to provide all-ceramic anterior bridges clinically. Five schools reported that their teaching of bridges had reduced over the past 5 years. Within the respondent schools, the most common challenges cited to

teaching bridges was a lack of suitable patients (13 schools) and lack of time within the primary dental degree programme (7 schools).

Conclusions: This study found increased student experience in the clinical provision of bridgework, in particular the provision of anterior cantilever resin-retained bridges, compared to the time of the last survey in 2009. Aspects of the teaching of removable partial dentures and implant dentistry should be surveyed to identify how these areas of teaching are adapting to changing patterns of oral healthcare and the further refinement of developing technologies in these areas.

Introduction

The replacement of missing teeth by means of removable partial dentures (RPDs), fixed bridges (bridges -fixed partial dentures), implant dentistry and complete dentures are fundamental elements of the repertoire of treatments provided by dental teams. Over recent decades, emphasis has shifted towards the rehabilitation of partially dentate adults, with the most recent UK Adult Dental Health survey indicating that the number of adults with 21 or more teeth has increased to 86% (from 73% in 1978).[1] In addition, there are many innovative and evolving technologies for the rehabilitation of partially dentate adults, including the use of digital dental impressions, CAD-CAM systems, minimally invasive approaches to treatment, all-ceramic restorations and dental implant based restorations of increasing sophistication and reliability. The challenge for dental schools is to produce dental graduates who are fit for purpose, safe beginners with the skills and understanding to embrace and employ novel, increasingly complex technologies.

Dental schools are under increasing pressures, including increased student numbers, a diminishing pool of suitably trained clinical academics to provide senior leadership in teaching and learning, a diminishing pool of 'suitable' patients and increased administrative challenges.[2] Many dental schools, despite having already crowded programmes of study, face the criticism that they are no longer "as good as they used to be".[3,4] A recent survey of the Fellows and Members of the Faculty of General Dental Practice (UK) found that while respondents felt they had learned and experienced 'enough' or 'a lot' of teaching in relation to crowns, there was a trend towards 'wishing to learn more' or 'deficient' learning in resin retained and conventional bridgework.[5] More worryingly, a recent survey of Dental

Foundation trainers found that 85% of those surveyed had concerns about the skills of recent dental graduates in relation to “crown and bridge”.[6] Clearly, areas for concern exist; however, it should be remembered that the exit point of dental school training within the UK is now the “safe beginner”, and that the purpose of Dental Foundation Training is, amongst others, to provide a sheltered, gradual transition to independent practice.[7] Furthermore, it is now recognised that dental school graduates are on a pathway of ‘life-long learning’. Dental school training is no longer a “start-stop” exercise – dental graduates are expected to adapt and refine their skills, knowledge and approaches to novel technologies over the course of their career.

Previous studies have identified concerns about the teaching of certain clinical subjects, including reductions in preclinical teaching in fixed and removable prosthodontics.[8-10] This, however, reflects continuing changes in patterns of oral health in society. For example, students no longer undertake as many full arch clearances and the provision of immediate complete dentures as was the case 30 years ago.[11] The last survey of teaching of fixed bridgework was completed by the authors in spring 2009 (8 years ago).[9] That survey found variation in teaching amongst schools. Cantilever, resin-retained bridgework was the most popular form of bridgework provided clinically (average 0.83 bridges per student), followed by conventional, cantilever bridgework (average 0.50 bridges per student). At that time, no schools reported that their students gained clinical experience in the provision of all-ceramic bridges.[9] With such considerations in mind, the aim of this study was to investigate the contemporary teaching of bridges within dental schools in Ireland and the United Kingdom.

Methods

Positive ethical approval (Cardiff Dental School Research Ethics Committee 15/45a) was obtained for this project. Following this, a pre-piloted questionnaire was distributed to each of the 18 dental schools in the United Kingdom and Ireland with primary dental degree programmes in January 2017.

The questionnaire was designed using internet based software (Bristol Online Survey, Bristol, UK), and included 23 questions (both “open” and “closed” designs were used).

It was requested that if the person receiving the email was not the most suitable person in the institution to answer the survey, that they would forward it to the most appropriate member of staff. The information sought included:

- Current levels of pre-clinical and clinical teaching of bridges;
- Clinical techniques taught in relation to bridges, including the use of articulators, impressions and cementation;
- Current and future challenges in the teaching of bridges.

Responses were received and collated anonymously.

Results

All 18 dental schools invited to take part in this survey provided a response (100% response rate).

Preclinical teaching

All schools provided primary dental degree students with teaching on bridges with eight reporting this teaching commencing in Year 4, nine in Year 3 and one in the first year of the typically five-year long programme.

The number of hours dedicated to preclinical clinical skills teaching varied from 5h to 60h, average 19.4h. The staff to student ratio ranged from 1:6 – 1:24, with 1:10 being the most commonly reported ratio. Schools were asked to outline recommended teaching materials (e.g. textbooks and other materials), specific to the teaching of bridges. These are summarised in Table 1.

The exercises completed by students in preclinical courses is detailed in Table 2. Fourteen of the schools (78%) reported that students are required to successfully complete a preclinical assessment prior to them being allowed to provide bridges in a clinical setting. This assessment involved:

- Crown preparation (9 schools)
- Tooth preparation for a conventional bridge (5 schools)
- Tooth preparation for a resin-retained bridge (2 schools)
- Oral examination (1 school)

Clinical teaching

Information on the numbers of different types of bridges typically provided by undergraduate students is summarised in Table 3. The information is difficult to interpret as not all schools answered all questions. Information is presented first on a 'best case scenario' – with an average having been calculated, based on the number of schools that responded. Information is then presented on a 'worst case scenario' – with an average having been calculated, assuming the response from the non-respondent schools to be '0' for the relevant categories. Finally, information has been presented from the 2009 survey, allowing identification of trends. Anterior cantilevered, resin-retained bridges were the most common treatment provided (average = 1.67 bridges per student per respondent school; range = 0 – 3; average= 1.11, including non-respondent schools, assuming their response to be 0). The mean number of anterior cantilever resin-retained bridges was twice that reported in 2009. Although low, an increase in the student clinical experience of providing fixed-fixed anterior bridgework since the time of the 2009 survey (average = 0.74 bridges per student per respondent school; range = 0 – 2; 2009 average= 0.27) was noted.[9]

Schools were asked to identify what teaching if any, they planned to introduce over the next 5 years. The most common responses were:

- All ceramic bridge work to replace posterior teeth (5 schools)
- All ceramic, resin-retained bridgework replacing anterior teeth (3 schools)

Prior to graduation, completion of requirements (i.e. targets, quotas), for bridges were mandatory in 5 schools. These requirements included the provision of:

- 2 resin-retained bridges (1 school)

- 1 resin-retained bridge and 1 conventional bridge (1 school)
- 2 bridges of any design (1 school)
- 1 bridge of any design (2 schools)

In addition, 2 schools required their students to complete 5 - 6 units of fixed prosthodontic treatment, which could include crowns or bridges.

Clinical techniques

Articulated study casts

Eleven schools required their students to have articulated study casts for the planning of bridges. The remaining 7 schools reported that articulation depended on the clinical circumstances, including the number of units, occlusal guidance, position and type of bridge.

All schools required student to take a facebow record for mounting the maxillary cast within the articulator. Fourteen schools used the Denar articulating system (Whip Mix Co, USA), 1 used both Artex (Amann Girrbach, Austria) and Denar articulators, whilst 3 schools provided no information on articulation.

Impression techniques

A summary of the impression techniques taught for recording master impressions for fixed bridges can be found in Table 4. By far the most common impression technique taught was the use of a 'putty and wash'/ polyvinylsiloxane in a stock tray.

Cementation techniques

A summary of the information obtained on cementation techniques taught for bridges is provided in Table 5. Glass-ionomer cements were the most popular luting cement taught for conventional bridgework (n=13 schools).

Eleven schools taught their students to place rubber dam when cementing resin-retained bridges. Comments from the remaining schools indicated that placement is dependent on the individual case. One respondent reported that rubber dam placement is dependent on the position of the margin on the abutment tooth. One school reported that they do not teach adhesive cements for conventional bridges to allow for easier retrievability.

Perceived challenges

Respondents were asked if the recently published General Dental Council (GDC) document *"Preparing for practice: Dental team learning outcomes for registration"* (2015)[13] had influenced the teaching of bridges. Two schools only confirmed that it had. The remaining schools reported that it had not, indicating that there was very little information in the document regarding bridges.

The following factors were reported to be the main challenges to teaching bridges to undergraduate dental students:

- Lack of suitable patients (13 schools)
- Lack of time within the programme (7 schools)
- The use of bridges to replace missing teeth has been superseded by alternative techniques such as implant supported restorations (6 schools)
- Lack of suitable teachers (1 schools)

One respondent stated there is *"no ability to standardise the experience of undergraduates because of the diversity in case presentation*".

Concerning developments within the teaching programmes over the previous 5 years:

- Two schools reported that the teaching of bridges had increased
- Five reported that the teaching of bridges had decreased
- Eleven reported that the teaching of bridges had remained unchanged over the past 5 years

Additional comments from respondents suggested that the changes in teaching were predominantly related to advancements in bridge technology, including adhesive cements, resin-retained bridges and implant-supported restorations.

Discussion

The results of this survey are considered heartening given the range of teaching and clinical experience received by students in fixed bridgework (bridges). While valid concerns exist in relation to a reduction in the amount of time spent on preclinical teaching of bridges, increases in the clinical experience gained by students, in particular in minimally invasive, cantilever, resin-retained bridges since the time of the last survey[8] are to be welcomed.

There are challenges in extrapolating the data reported, given a number of schools not having provided comprehensive information on the numbers of bridges completed by their students. The current survey indicates that students each completed, on average 1.67 anterior cantilever, resin-retained bridges. If the data is recalculated, assuming students in non-respondent schools undertook no such treatments, the average drops to 1.11 bridges per student. Whichever figure is chosen, there has been an increase in overall clinical experience. Accepting the mean value of 1.67 bridges, this represents a two-fold increase since the time of the last survey in 2009 (mean= 0.83 per student)[8]. Resin-retained bridges offer many advantages over conventional bridgework, not least the avoidance of the iatrogenic damage associated with conventional bridge preparations.[14] At a time when dental schools are often criticised for the nature and amount of teaching provided to students, the results of this study indicate that, in the main, students are gaining clinical experience in contemporary, evidenced-based approaches to bridgework, sufficient to satisfy the expectations of a 'safe beginner'. That said, students were found to have gained

reduced experience in more ‘traditional’ forms of treatment such as conventional bridgework, posing challenges when new graduates encounter patients with failing conventional bridgework in need of replacement. Such dilemmas are not new in undergraduate dental education, which rightly and properly should focus on approaches and techniques in the best interests of patients. It is better for the new ‘safe beginner’ graduate to fit for future purpose than fit for just immediate purpose.

In keeping with approaches encouraged by the General Dental Council, it is positive to note that 14 of the 18 respondent schools had a preclinical, ‘gateway’ assessment which had to be completed prior to undertaking bridgework clinically.[13] In many schools, such assessment was linked to assessments of the preparation of teeth to receive crowns (9 schools). The arrangements in the other 4 schools were unclear. In the interests of patients of students, it is suggested that preclinical gateway assessments should be the norm.

It was noted that 5 schools only had numerical requirements (i.e. targets or quotas), for bridgework prior to graduation. This reflects changes in dental education whereby students are encouraged to focus on whole patient care, rather than running the risk of over-treatment to attain numerical requirements. It is suggested that the approach whereby students are required to complete a number of courses of patient care involving a full range of contemporary treatments, including bridgework, provides the best compromise. The view that students should not graduate if they have failed to gain competence, not just experience in all procedures common to everyday clinical practice is strongly supported. If patients requiring certain forms of treatment are difficult to recruit

for care in undergraduate dental student clinics, given changes in patterns of oral disease and treatment needs, then such treatments can no longer be considered common to everyday clinical practice, and should not be a barrier to dental students graduating.

The present survey highlighted concerns about the recruitment of patients to student clinics requiring bridgework. As many as 13 of the 18 respondent schools highlighted such concerns. The treatment needs of patients attending dental school, undergraduate clinics are centred around the maintenance of heavily restored dentition, rather than the treatment of new disease. This poses many challenges for dental schools, working to comply with outdated educational guidance. The development of community-based clinical teaching/ outreach centres has alleviated some of the problems, but it is suggested that the respite will be relatively short-lived. A previous study run in the community-based clinical teaching centre at Cardiff found that student confidence in the provision of conventional and resin-retained bridgework benefited from a statistically significant increase, following a one-year placement at the centre;[12] however, it is considered highly unlikely that this increase is sustainable, especially given that the provision of treatments such as bridgework may not be considered to be the focus of care in community-based outreach centres. The disconnect between what is presently viewed by the GDC as important to becoming a 'safe beginner' and what is required to safely begin practising everyday clinical dentistry, ideally as part of integrated, whole patient care is considered to be cause for concern.

Two respondent schools were noted to permit their students to provide all-ceramic bridges. A further 5 schools planned to introduce such teaching over the next 5 years. Embracing novel and evidence-based treatments is to be encouraged, particularly as students will be called upon to provide such treatments once graduated However, all-ceramic preparations are more invasive than traditional metal-ceramic preparations, thereby increasing the risk of potential loss of pulp vitality, and there would appear to be little, if any teaching of implant dentistry alternatives in such situations. All-ceramic bridges have a place in contemporary clinical practice, but this should be in the context of alternative approaches to the management of the replacement of lost teeth which may better help retain more natural teeth.[15,16] To teach all-ceramic bridges as an alternative to traditional bridgework, but not in the context of modern alternatives to lost tooth replacement is at best confusing to students.

Conclusion

This study has found increased student experiences in the provision of clinical fixed bridgework treatments, in particular in relation to the provision of anterior cantilever resin-retained bridges, compared to the time of the last survey in 2009. Diversity in approach is noted between some schools in terms of teaching of fixed bridgework, including a reduction in the average amount of time spent teaching fixed bridges in the preclinical teaching areas. Novel approaches to the delivery of teaching, such as e-learning and engaging with community based clinical teaching is to be encouraged. Similar aspects of teaching for removable partial dentures and implant dentistry should be surveyed to identify how these areas of teaching are adapting to changing patterns of oral healthcare and the further refinement of developing technology in these areas.

Acknowledgements

The authors are extremely grateful to their colleagues who took time from their busy schedules to complete the questionnaire.

References

1. UK Adult Dental Health Survey 2009. Available from http://digital.nhs.uk/catalogue/PUB01086 . Accessed 26th October 2017.

2. Lynch CD, Ash PJ, Chadwick BL, Treasure ET. Community-based clinical teaching. *British Dental Journal* 2009; 22: 141.

3. Cabot LB, Radford DR. Are dental graduates as good as they used to be? *British Dental Jounal* 1999; 186: 318–319.

4. Islam S. Devoid of dentistry. *British Dental Journal* 2012; 212: 163

5. Oliver GR, Lynch CD, Chadwick BL, Santini A, Wilson NHF. What I wish I'd learned at dental school. *British Dental Journal* 2016; 221: 187 – 194.

6. Oxley CJ, Dennick R, Batchelor P. The standard of newly qualified dental graduates – foundation trainer perceptions. *British Dental Journal* 2017; 222: 391 - 395.

7. Lynch CD, Ash PJ, Chadwick BL, Herbert RA, Cowpe JG. Developing the continuum of dental education: including dental foundation trainers in the delivery of a community-based clinical teaching programme. *British Dental Journal* 2012; 213: 571 – 521.

8. Lynch CD, Allen PF. The teaching of removable partial dentures in Ireland and the United Kingdom. *British Dental Journal* 2007; 203: E17.

9. Lynch CD, Singhrao H, Addy LD. Gilmour ASM. The teaching of fixed partial dentures in undergraduate dental schools in Ireland and the United Kingdom. *Journal of Oral Rehabilitation* 2010; 37: 908 – 915.

10. Clark RKF, Radford DR, Juszczyk AS. Current trends in complete denture teaching in British dental schools. *British Dental Journal* 2010; 208: E10.

11. Youngson CC. Hindsight isn't always 20/20. *British Dental Journal* 2012; 212: 473 – 474.

12. Lynch C D, Ash P J, Chadwick B L, Hannigan A. Effect of community-based clinical teaching programs on student confidence: a view from the United Kingdom. *Journal of Dental Education* 2010; 74: 510–516.

13. General Dental Council. Preparing for Practice. 2015. Available from https://www.gdc-uk.org/professionals/education. Accessed 26th October 2017.

14. Durey KA, Nixon PJ, Robinson S, Chan MFWY. Resin bonded bridges: techniques for success. *British Dental Journal* 2011; 211: 113 – 118.

15. Kern M. Fifteen-year survival of anterior all-ceramic cantilever resin-bonded fixed dental prostheses. *Journal of Dentistry* 2017; 56: 133- 135.

16. Sasse M, Kern M. Survival of anterior cantilevered all-ceramic resin-bonded fixed dental prostheses made from zirconia ceramic. *Journal of Dentistry* 2014; 42: 660 – 663.

Tables

Table 1. Recommended textbooks for undergraduate teaching of fixed bridges among respondent schools.

Textbook	Number of Schools
Shillingburg HT *et al.* "Fundamentals of Fixed Prosthodontics", Quintessence Publishing Co. (1997)	13
Wassell RW *et al*. "A Clinical Guide to Crowns and other Extra-Coronal Restorations": BDJ Book (2002)	11
Rosenstiel SF *et al.* "Contemporary Fixed Prosthodontics", Mosby Publishing Co. (2006)	7
Ricketts D, Bartlett D "Advanced Operative Dentistry: A Practical Approach", Churchill Livingstone. (2013)	3
Smith BGN, Howe LC. “Planning and Making Crowns and Bridges”, Informa Healthcare (2006).	2
Summit JB et al. “Fundamentals of operative dentistry: a contemporary approach”, Quintessence Publishing Co. (2006)	1
Internal school manuals or documentations	9
Publications / Systematic Reviews	2
Online Lectures	1

Table 2. Exercises completed in the pre-clinical courses for fixed bridges (responses received from all 18 schools)

Exercise	Number of Schools
Preparation for conventional fixed bridges:	
Fixed-Fixed anterior	10
Fixed-Fixed posterior	14
Cantilever anterior	6
Cantilever posterior	5
Preparation for resin-retained fixed bridges:	
Fixed-Fixed anterior	7
Fixed-Fixed posterior	9
Cantilever anterior	13
Cantilever posterior	9
Preparation for all - ceramic fixed bridges:	
Anterior	3
Posterior	0
Provisional fixed bridge making	16
Waxing up exercises	9

Table 3. Clinical experience gained in the provision of fixed bridges by undergraduate students.

Bridge type	Average number provided	Range	Number of responses	Average number provided (assuming non-respondents do not teach this technique)	Average number reported in 2009 survey
Conventional fixed bridge:					
Fixed-fixed anterior	0.74	0 - 2	11	0.45	0.27
Fixed-fixed posterior	0.7	0 - 2	10	0.39	0.44
Cantilever anterior	0.82	0 - 2	11	0.5	0.5 (cantilevers reported as one category)
Cantilever posterior	0.73	0 - 2	11	0.45	
Resin-retained fixed bridge:					
Fixed-fixed anterior	0.89	0 - 5	9	0.45	0.42
Fixed-fixed posterior	0.89	0 - 5	7	0.34	0.33
Cantilever anterior	1.67	1 - 3	12	1.11	0.83 (cantilevers reported as one category)
Cantilever posterior	0.94	0 - 2	8	0.42	
All - ceramic fixed bridge:					
Anterior conventional	0.25	0 - 1	8	0.11	0
Posterior conventional	0.00	0 - 0	8	0.00	0
All - ceramic resin – retained	0.00	0 - 0	8	0.00	Not considered

Table 4: Impression techniques taught for recording the master impression for fixed bridges

	Fixed Bridge Type		
Impression technique	**Conventional**	**Resin Retained**	**All Ceramic**
Light-bodied polyvinylsiloxane in special tray	4	6	1
Medium-bodied polyvinylsiloxane in a special tray	3	4	3
Putty & wash polyvinylsiloxane in a stock tray	12	12	8

Table 5. Cementation techniques taught for fixed bridges

	FPD Type		
Cementation technique	**Conventional**	**Resin-retained**	**All-ceramic**
Adhesive Resin Cement	8	16	6
Conventional Resin Cement	2	1	8
Glass Ionomer Cement	13	0	1
Zinc Phosphate	9	0	1
Zinc Polycarboxylate	4	0	1