Making Sense of Complication Reporting Associated with Fixed Dental Prostheses

Chipping of ceramic veneering materials is a complication associated with fixed dental prostheses (FDPs) that has provoked significant discussion in recent years. However, two recent articles emphasize the difficulty in reconciling the clinical relevance of the reported data. The first study reported 0.2% porcelain chipping/fracture in a sample of 2,340 metal-ceramic crowns.[1] The second reported an up to 34% incidence of chipping of the porcelain veneer in metal-ceramic FDPs.[2] These observations seem vastly contradictory. As the author of the first paper, I have a problem. Am I a poor observer, or have I committed scientific fraud?

Patients are likely to value their prostheses if they perceive the associated longevity justifies the initial direct and indirect costs (economic, time, opportunity, and discomfort)[3] and also the ongoing maintenance costs. Maintenance involves both anticipated treatments (routine) and non-anticipated treatments (complications). Complications, which incur significant monetary costs, will particularly impact the perceived value (worth or importance) that patients derive from their prostheses.

Patients expect to be guided by their clinician when considering various treatment options. The clinician can provide initial clinical and anticipated ongoing maintenance costs and the documented longevity outcomes and predictions based upon their knowledge of the literature and their own clinical experience. However, patients also expect the clinician to provide some information on non-anticipated follow-up treatments, also based on their experience and/or knowledge of the literature. Patients can then make informed judgements on what value they are likely to experience from their treatment.

Many outcome studies publish information on complications associated with tooth- and implant-supported FDPs. However, the heterogeneity of classifications, the subjective evaluations often involved, and the differences in interpreting the severity of the complication preclude comparison between materials and techniques and different types of prostheses. In their systematic review, Pjetursson et al[4] compared the survival and complication rates of tooth- and implant-supported FDPs and single crowns. Several shortcomings in the description of post-issue complications were identified. They recommended that survival outcomes be reported in combination with the type and incidence of complications per time interval, that both biologic and technical complications be identified, the complications be graded relative to severity, and the time/cost involved for treatment recorded.

Complications associated with different materials and components are common. As previously noted, the reporting of chipping of ceramic veneering can be confusing and misleading. A closer examination of the previously cited papers provides more insight into the apparent gross discrepancy between the reported incidences. In my own paper,[1] chipping/fracture was only reported if it resulted in the consequence of replacement of the crown. In the second paper,[2] chipping incidence was tallied following examination of replicas of the veneer surface with a scanning electron microscope (SEM), irrespective of whether the incident resulted in any consequence or not. It is the consequences of the complication that has resulted in the apparent discrepancy in this reported data.

The consequences of the complication of veneer chipping are varied. A minor chip that may not be noticed by the patient could be ignored or similarly classified with a major chip that involved the entire proximal surface of the restoration, caused patient discomfort, and commanded significant treatment or even crown/prosthesis replacement. Both complications will therefore impact differently on the patient's perceived value of their prosthesis and be open to assessor bias. A randomized reexamination of a sample of the outcome of crowns reported in my paper indicated that several instances of chipping could be detected. These were inconsequential, had not necessitated any treatment other than smoothing, and were not a patient concern. It is likely that if replica samples of the occlusal surfaces were obtained and examined under an SEM, many more incidences of chipping would be recorded.

Thus, it is the consequences of a complication that determine its clinical relevance. The cited papers give testimony to the need for clarification in the reporting of complications associated with dental prostheses.

Comparing complications across different treatment modalities is difficult. For example, the incidence of loss of tooth vitality and its consequences in tooth-supported prostheses is difficult to equate to any complication associated with implant-related prostheses. Likewise, the incidence of screw fracture and its subsequent consequences is difficult to equate to any complication with tooth-supported prostheses. Both of these complications have been reported to occur with relatively high frequency and

will therefore impact on the value derived from the prostheses. It might not be considered possible to compare these events practically—akin to comparing apples with oranges. However, comparing value between different treatment options over a projected clinical service time is an almost every day clinical reality, eg, comparing treatment modalities such as a tooth-supported three-unit FDP with a single implant-supported crown.

Ambiguity also arises in the qualitative assessment of the severity of complications. The qualitative terms minor, moderate, and major have been variously used, but are based on a subjective evaluation. In one study, it was conceded that the majority of minor complications were treated during routine recall appointments and therefore fiscally inconsequential.[5]

The treatment of complications that is not part of a routine maintenance appointment incurs a fiscal burden for either the clinician or the patient. A comparison of monetary costs between different treatment modalities has been documented.[6] However, monetary costs for either initial or retreatment costs vary significantly between different practice settings and different countries. Monetary quantum will also vary over time depending on inflation.

Similar problems occur if treatment time is used as the basis for comparison. Different clinicians have different clinical time-related productivity. In addition, a quantitative collation of retreatment time does not distinguish between those complications that do or do not incur a fiscal burden (eg, treatment within a routine maintenance appointment) and does not take into account laboratory or component costs associated with the retreatment. Comparisons would also be limited to prospective assessments, as notation of specific treatment times for specific procedures within the one appointment, is not usual clinical practice.

Although dentistry is part of the health profession, the reality is that private dental practices are a business. To remain viable, a business must return a profit. A practical way to achieve this is to establish a time-based fiscal accounting unit (TAU). This relates to a reconciliation of the fixed and variable costs of the practice and expected income (related to operator productivity and a profit margin) over a specific time period.

Many restorative dental practices use 30 minutes as a basic time division for allocation of patient treatment visits. A 30-minute TAU can be calculated that applies to all procedures. This is commonly termed a billing rate. The number of TAUs required for different treatment modalities, techniques and materials can be collated and compared. Although the dollar value of the TAU may vary over time, the number of units for a given procedure will remain constant. Thus, all procedures undertaken in the practice can be compared. The TAUs can also be collated for treatment of complications.

Another advantage of collating the number of fiscal units for a given treatment over specific monetary costs (currency amounts) is that different practice settings can be compared. A single TAU might be valued at $500.00 in one practice setting and $250.00 in another. However, the number of units would be constant, even if the profit expectations and productivity of the operators varies. Data from different practices both locally and across countries could be pooled.

Proposed Classification of Complications

Identification of complications can be either patient or clinician initiated. The clinician can identify nonsymptomatic complications during a previously allocated routine maintenance visit and address these as part of that visit. These complications would be considered fiscally "inconsequential." These would include procedures such as adjustment of the occlusion, tightening of an implant abutment screw, resealing a screw access hole, smoothing of minor chipping of veneering material that is not an esthetic concern for the patient, or splinting of increasingly mobile teeth. Alternatively, further visits would be allocated depending on the severity of the complication. Referral to another specialty may also be indicated.

Patients may experience a complication, contact the practice, and be allocated a nonroutine appointment. This will invariably incur a fiscal cost for either the patient or the clinician. If the practice routine is to allocate a 30-minute segment for assessment, diagnosis, and possible treatment, then this would equate to one TAU. Following examination and assessment, the complication can be either addressed at this visit (qualitatively, this could be termed a "minor" complication) or further appointments allocated. This could include procedures such as smoothing chipped material to improve patient comfort, tightening of a loose screw, recementation of a successful prosthesis, treatment of mucositis, restoration of a marginal carious lesion, or resealing of a screw access hole that had become a patient concern.

More extensive treatment would involve either extended time segments or multiple 30-minute visits. The equivalent TAUs can be allocated. Qualitatively, two TAUs could be considered a "moderate" complication and more than two a "major" complication. A complication resulting in loss of the prosthesis or its support would be classified as a "terminal" complication (failure).

Laboratory and implant component costs associated with treatment of complications can also be accounted for. If these costs are between 50% and 100% of the practice TAU, another unit is added to the quantum. Additional units are added for higher costs pro-rata.

For example, replacement of two easily retrieved fractured abutment screws in an implant-supported prosthesis identified in a patient initiated nonroutine appointment might equate to two TAUs (one for the nonroutine appointment and one for the component cost of the screws equating to 65% of a TAU) and qualitatively be considered a moderate complication.

Costs of treatment of the complication provided by other clinicians are included in the TAU allocation. Unless otherwise determined, it is assumed that the values of the TAUs of the referred to practices are equivalent and the quantum based on treatment time. For example, identification of an endodontic problem in a patient initiated nonroutine appointment requiring debridement and obturation of the root canal and not involving significant component or laboratory costs could equate to five TAUs (one TAU for the nonroutine appointment involving assessment and diagnosis, three for the 1.5 hours of specialty endodontic treatment, and one for postendodontic restorative treatment) and qualitatively be considered a major complication.

The fiscal burden of treatment of any complication can be quantified in TAUs. The one complication type could even be classified qualitatively as routine maintenance, a minor, moderate, or even a major complication, or quantitatively in varying numbers of TAUs, depending on the complexity of the treatment involved.

For example, a chipped or fractured veneer on an implant-supported prosthesis may be smoothed during routine recall (inconsequential complication; 0 TAUs), may be smoothed to improve patient comfort following nonroutine presentation (minor complication; 1 TAU), may require removal and indirect repair involving a commercial laboratory component to restore acceptable esthetics (major complication; 4 TAUs), or may result in replacement of the prosthesis (terminal complication). A mobile implant-supported prosthesis prompting a patient-initiated nonroutine appointment may be treated by tightening an accessible loose abutment screw (minor complication; 1 TAU), may require replacement (component cost) of a fractured, but easily retrieved screw (moderate complication; 2 TAUs), may require a time consuming screw extraction procedure with subsequent screw replacement (major complication; 3 TAUs), or involve replacement of a cemented prosthesis that fractures while accessing the loose abutment screw (terminal complication).

Table 1 Hypothetical List of Complications of Three-Unit TFDPs and Implant Single Crowns Over 15 Years

	Prosthesis type		
	Three-unit TFDPs (n = 200)	Implant single crowns (n = 200)	Total (n = 400)
Inconsequential	36	55	91
Fiscally consequential			
Minor	26	31	57
Moderate	5	2	7
Major	9	2	11
Subtotal	40	35	75
Terminal	11	3	14
Overall total	87	93	180

TFDPs = tooth-supported fixed dental prostheses.

The qualitative and quantitative assessment of biologic and technical complications is easy to document and collate. The accompanying tables (Tables 1 and 2) illustrate how data might be documented for hypothetical tooth and implant-supported FDPs.

Advantages and Limitations of the Proposed Classification

This proposed classification would minimize both heterogeneity in the reporting of complications and ambiguity in comparisons between different treatment modalities within the one or different practice settings. It is easy to apply retrospectively as well as prospectively. Most practices, institutional or privately based, have records of occasions of treatment. Although inconsequential complications addressed at anticipated maintenance visits may not be recorded, appointment time allocations for other clinician or patient-initiated treatment of complications involving nonanticipated appointments would be.

The accounting value of the TAU remains constant over time and is not affected by specific monetary costs. One TAU may be $500.00/hour in year one, but is still one TAU 10 years later, even if the rate is $600.00/hour. Thus, the incidence over an extended time interval can be readily obtained and the equivalent complication burden quantified in the one practice. In addition, different practice settings can be compared.

Any classification has its limitations. Complication incidence is unpredictable and independent of the timing of anticipated maintenance appointments. Fracture of an abutment tooth or implant-supported prosthesis screw may occur the day after an anticipated maintenance visit. The frequency of these

Table 2a Hypothetical Cause, Treatment, and Fiscal Burden of Consequential* Complications in Three-Unit Tooth-Supported FDPs (n = 200) Over 15 Years

Complication cause	n	Treatment performed	Fiscal burden (TAUs)	Mean CST (mo)	CST range (mo)
Biologic					
Bleeding/sensitivity	3	Modified oral hygiene	3	46	8–152
Loss of tooth vitality	7	Orthograde RCT	32	44	1–124
Tooth fracture: corono-radicular	1	New post (wrought) + core	2	107	NA
Marginal caries	4	Crown/retainer margin modified	5	44	25–91
Pain	6	Adjusted occlusion	10	54	1–168
	1	Occlusal splint	2	2	NA
Increasing mobility	2	Adjusted occlusion	2	19	4–33
Discomfort	5	Recontoured pontic/retainers	9	20	1–81
Mechanical					
Chipping of porcelain	4	Smoothed porcelain	4	102	8–175
Chipping/fracture of porcelain	3	Porcelain repair/composite	3	23	1–35
Loss of retention of crown/retainer	3	Recemented retainer	3	46	21–59
Lingual perforation	1	Palatal/lingual seal	1	65	NA
Total	40		76		

TAUs = time-based fiscal accounting units; CST = clinical service time of the prosthesis before the complication occurred; RCT = root canal treatment.
*Combined minor, moderate, and major.

Table 2b Hypothetical Cause, Treatment, and Fiscal Burden of Consequential* Complications in Implant Single Crowns (n = 200) Over 15 Years

Complication cause	n	Treatment performed	Fiscal burden (TAUs)	Mean CST (mo)	CST range (mo)
Biologic					
Pain	2	Adjusted occlusion	2	65	29–100
Discomfort	1	No treatment	1	15	NA
Implant-associated infection	12	Implant infection control without flap	12	58	6–133
	2	Implant infection control with flap	11	62	NA
Mechanical					
Abutment screw loosening	12	Tightened screw	12	43	1–140
Abutment screw fracture	1	Abutment screw replaced	2	180	NA
Lost screw access seal	3	New screw access seal	3	9	1–23
Chipping of porcelain	1	Smoothed porcelain	1	15	NA
Superstructure: lost cement retention	2	Recemented	2	54	54–56
Total	35		46		

TAUs = time-based fiscal accounting units; CST = clinical service time of the prosthesis before the complication occurred.
*Combined minor, moderate, and major.

visits will be determined by several patient-based factors (eg, capacity for effective hygiene) and specific treatment-related factors (eg, complexity of the prosthesis[es]). The subjective nature of this allocation may affect the incidence of inconsequential and minor complications. A patient on a 3-month recall regimen, who incurs a noticeable but not significantly uncomfortable material chip, may decide to wait for the next scheduled routine appointment rather than initiating a nonroutine appointment. On the other hand, a patient with a similar complication who has 18 months until their next scheduled routine appointment may present for nonroutine treatment soon after experiencing the complication. Patients though are likely to seek immediate treatment for major complications, irrespective of any scheduled routine maintenance appointments.

Summary

The current reporting of complications associated with FDPs is inadequate and misleading. Complications, which incur significant monetary costs, will particularly impact the perceived value (worth or importance) that patients derive from their prostheses.

Effective documentation of complications should include type (biologic and technical), incidence, and severity. The fiscal burden of treatment should be

quantified. Comparisons of different restorative materials, techniques, and procedures should be meaningful. Data collated prospectively or retrospectively and pooled over time should allow for comparisons within and between different practice settings. The proposed classification, based on the fiscal consequences of complications, achieves these objectives.

Effective documentation of complications in conjunction with actual or projected survival data and personal clinical experience will enable clinicians to provide realistic information of the expected clinical service of dental prostheses.

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References

1. Walton TR. The up to 25-year survival and clinical performance of 2,340 high gold–based metal-ceramic single crowns. Int J Prosthodont 2013;26:151–160.
2. Christensen R, Ploeger B. A clinical comparison of zirconia, metal and alumina fixed-prosthesis frameworks veneered with layered or pressed ceramic: A three-year report. J Amer Dent Assoc 2010;141:1317–1329.
3. Walton T, Layton D. Cost satisfaction analysis: A novel patient-based approach for economic analysis of the utility of fixed prosthodontics. J Oral Rehabil 2012;39:692–703.
4. Pjetursson BE, Bragger U, Lang NP, Zwahlen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs). Clin Oral Implants Res 2007;18(suppl 3): 97–113.
5. De Boever A, Keersmaekers K, Vanmaele G, Kerschbaum T, Theuniers G, De Boever J. Prosthetic complications in fixed endosseous implant-borne reconstructions after an observations period of at least 40 months. J Oral Rehabil 2006;33:833–839.
6. Brägger U, Krenander P, Lang N. Economic aspects of single tooth replacement. Clin Oral Implants Res 2005;16:335–341.