Factors affecting the complexity of dental implant restoration – what is the current evidence and guidance?

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In brief

Gain a better understanding of assessing the complexity of dental implant treatment and know when to refer.

Discusses how to achieve safer practice for increased patient safety.

Provides an evidence-based assessment of current indices.

Objectives The aim of this paper is to identify the factors that affect the complexity of implant restoration and to explore the indices that help us to assess it. With this knowledge the growing number of clinicians restoring dental implants will have a better understanding of the available guidance and evidence base, and the differing levels of competence required. **Study design** A literature review was conducted. The selection of publications reporting on complexity was based on predetermined criteria and was agreed upon by the authors. After title and abstract screening 17 articles were reviewed. The articles that were utilised to form the ITI SAC tool and Cologne Risk Assessment we also included. **Assessing complexity** Two key guides are available: International Team for Implantology's Straight-forward Advanced Complex tool[4] and the Cologne ABC risk score.[5] While these guides help identify treatment complexity they do not provide a strong enough evidence base from which to solely base clinical decisions. The key patient factors are expectation, communication, the oral environment, aesthetic outcome, occlusion, soft tissue profile and the intra-arch distance, whereas the key technical factors are impression taking, type of retention, loading protocol and the need for provisional restorations. Human factors also have a significant effect on complexity, specifically, the experience and training of the clinician, team communication and the work environment. **Conclusions** There are many interconnecting factors that affect the complexity of dental implant restoration. Furthermore the two widely used indices for the assessment of complexity have been investigated, and although these offer a good guideline as to the level of complexity, there is a lack evidence to support their use. The development of evidence-based treatment and protocols is necessary to develop the current indices further, and these need to be expanded to include other critical areas, such as human factors. A practical guide to aid practitioners in reducing complexity has been proposed.

Introduction

Dental implants are at the forefront of today's clinical practice, providing patients with answers for the treatment of all forms of edentulism.[1] For many patients, it has now become the standard pathway of care.[2]

With more and more dentists of all levels of experience restoring dental implants there is a need to understand and manage the factors that govern the degree of complexity of dental implant restoration.

The General Dental Council[3] states that clinicians must have the skills and knowledge necessary for competence, and provide a good standard of care based on the available up-to-date evidence and reliable guidance. The clinician must take an evidence-informed and patient-centred approach.[3]

Despite this requirement, there is little assessment of the evidence that supports the most frequently used indices of complexity, or critical analysis of the factors affecting it.

Understanding the potential complexity of any treatment enables the clinician to judge their competency to provide it. Paradoxically, for the inexperienced clinician, it is the plethora of unanticipated factors that compound complexity.

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Objective

The aim of this paper is to identify the factors that affect the complexity of implant restoration and to explore the indices that help us to assess it. With this knowledge the growing number of clinicians restoring dental implants will have a better understanding of the available guidance and evidence base, and the differing levels of competence required.

Study design

An electronic search was performed utilising PubMed, mbase, ncbi and Google Scholar. Key search terms were: 'Dental Implant Restoration', 'Complexity of Treatment AND Dental Implants' and 'Complications AND Dental Implant Restoration'.

Table 1 Comparison of assessment features of the ITI SAC[4] and Cologne ABC Risk Assessment[5] guides

ITI SAC	Cologne ABC
Patient expectations	Patient expectations
Oral hygiene and compliance	Oral hygiene
Craniofacial/skeletal growth	Not included
Access	Not included
Number of implants to be placed	Number of implants to be placed, adequate number and distribution
Fixed or removable	Fixed or removable
Anterior or posterior	Outside aesthetic zone/inside aesthetic zone
Visibility on smiling	High/medium/low smile line
Biotype	Attached gingivae/biotype
Shape of tooth crowns	Not included
Restoration of neighbouring teeth	Asks if healthy, does not discuss if restored
Soft tissue contour and volume	Not included
Interarch distance	Interarch distance
Mesiodistal space	Mesiodistal space
Loading protocol	Immediate, delayed, late placement
Bruxism	Bruxism
Use of provisional	Not included
Type of retention	Not included

We restricted our search to English language journals only. The search was restricted to systematic reviews and meta-analysis. Case reports or case series, observational studies, review articles/letters and studies which did not assess dental complexity were excluded from the review.

After title and abstract screening 17 of the 5,970 publications searched fulfilled the above inclusion criteria, and were identified for full text reading. The articles used to support the two published assessment tools were also reviewed to establish the evidence base supporting these guides.

Through consensus discussion drawing on these published articles and clinical experience, the authors generated a list of the key factors that affect complexity.

Assessing complexity

Two key guides are available: International Team for Implantology's Straightforward Advanced Complex tool[4] and the Cologne ABC risk score.[5] While these guides help identify treatment complexity they provide a limited evidence base from which to base clinical decisions.

The ITI SAC[6] was developed following a consensus conference of a multidisciplinary group of 28 clinicians. It was developed to aid clinicians in risk assessing and planning surgical and restorative cases.[6] This guide includes a broad spectrum of evidence from 1981 to 2015, including systematic reviews, consensus statements, primary research papers and ITI treatment guides. The appropriate protocols were then developed by a consensus from expert clinicians. The guideline, however, has a potential for bias given its funding by Straumann AG Holdings for use with ITI implants.

The second guide is the Cologne ABC Risk Assessment.[5] This is clearly laid out and is based on applying a red, amber, green scale to identified risks for complications, which they relate to complexity. It, like the ITI SAC, was developed by a consensus group, but on comparison, the ITI SAC classification covers restorative processes in greater detail.

The assessment features of the guides are compared in Table 1, and the key articles used to compile the guides is summarised in Table 2.

Factors affecting complexity

Patient factors

Expectation and communication

High patient expectations lead to increased case complexity and are commonly due to the insufficient provision of information.[7] Strietzel reported that 75% patients were given insufficient information regarding all available treatment options, risks, outcomes and costing.

Medico-legally it is essential to discuss the risks and benefits of both having and not having treatment, and this is to be accompanied by a breakdown and explanation of available treatment choices including the range of cost.[3] Furthermore, a practitioner must ensure the patient has knowledge regarding the management of complications or failures and this information must be fully documented. Only by providing this can consent be fully obtained.[8] This process of informed consent ensures that the patient's expectations are realistic and the complexity is modified.

Communication in any treatment is vital;[9] an understanding between the clinician and patient regarding reasonable expectations must be achieved.[10] Belser *et al.* lists patients' expectations as having a long lasting aesthetic and functional result that has as high degree of predictability, involves minimal invasion and risk, with discomfort and is cost effective.[11]

Oral environment

The oral environment presents a key factor in the complexity of treatment. Dawson and Martin concluded that a healthy mouth, free from active disease should be established before embarking on implant treatment.[6]

The original reason for tooth-loss should be established; tooth-loss through periodontal disease and bruxism predisposes a patient to an increased risk of complications and will guide the restorative treatment plan. The possibility of modifying the shape of adjacent teeth may also be desirable; virgin teeth adjacent to an edentulous saddle may hamper a clinician's ability to make these adjustments, making the treatment more complex.

Limited mouth opening hinders access to posterior sites. Thirty millimetres of opening is regarded as a minimum requirement for access. Restricted access may not only alter the treatment plan but can also limit the number and position of the implants.[6]

Table 2 Assessment of the key articles supporting the indices (cont. on page 618)

Assessment of supporting literature						
Authors/year/ citation	**Title**	**Type of Study**	**Sacketts Hierarchy of Evidence**	**Relevance**	**Strengths**	**Weaknesses**
Dawson, Chen, Buser, Cordaro, Martin, Belser 2009[6]	SAC Classification	Treatment Guide	2-4	High	A broad assessment of available literature which was used as a basis for a consensus conference of experts. The proceedings of the conference were used to establish the SAC classification as a practical tool kit which can be used to assess complexity of cases.	Not a systematic review. No methodology indicated in reaching evidence base. Does not address the question of bias. Evidence from 2009 onwards not addressed.
Martin 2015[1]	Prevention of Esthetic Complications Utilising the Esthetic Risk Assessment Analysis	Journal Article/Case Presentation	2-4	Moderate	Journal article relating to the ERA. Adds to the context of the ITI treatment guide by including relevant literature in the intervening period (2009-2015).	Not a Systematic review or RCT. Low numbers of RCTs used in literature. Possibility of bias as sole author publication.
Chen, Buser 2008b[65]	ITI Treatment Guide Volume 3. Implant Placement in post Extraction Sockets, Treatment Options	Treatment Guide.	2-4	Moderate	A broad assessment of available literature which was used as a basis for a consensus conference of experts Protocols are supported by case studies to provide relevant examples.	Not a systematic review. No methodology indicated in reaching evidence base. Does not address the question of bias. Evidence from 2008 onwards not addressed.
Sadowsky, Fitzpatrick Curtis 2014[66]	Evidence-Based Criteria for Differential Treatment Planning of 4 Implant Restorations for the Maxillary Edentulous Patient	Review Article	4	High.	Considers all aspects of treatment planning. Uses a graded evidence base according Sackett et al. 1996 Draws on systematic reviews in particular Sadawsky et al. 2007 Broad evidence base and extensive bibliography."	Not a systematic review. No methodology indicated in reaching evidence base. Does not address the question of bias, although the authors state no conflict of interest.
Carpentieri Drago 2011[19]	Treatment of Edentulous and Partially Edentulous Maxilla: Clinical Guidelines	Clinical Guidelines	2-4	High	A Literature review. Comprehensive and relevant to assessment, treatment considerations and clinical factors.	A lack of systematic approach to gathering the evidence. Not a systematic review Bias – may have chosen articles to support points Does not grade quality of evidence used.
Daniel Wismeijer, Paolo Casentini, German Gallucci 2010[68]	ITI Treatment Guide Vol 4 - Loading Protocols in Implant Dentistry Edentulous Patients.	Treatment Guide	2-4	High	A broad assessment of available literature which was used as a basis for a consensus conference of experts. The proceedings of the conference were used to establish the SAC classification as a practical tool kit which can be used to assess complexity of cases.	Not a systematic review. No methodology indicated in reaching evidence base. Does not address the question of bias. Evidence from 2009 onwards not addressed.
Esposito, Grusovin *et al.* 2013[60]	Interventions for replacing missing teeth: Different Times for Loading Dental Implants	Cochrane, systematic review	1	High	Broad Assessment of available literature Systematic review of the available RCTs	Low number of RCTs available. Lack of differentiation between case type, for instance single tooth vs edentulous arch; the discussion, results and conclusions talk generically about all cases.
Moraschini, Porto Barboza 2016[62]	Immediate versus conventional loaded single implants in the posterior mandible: a meta-analysis of randomized controlled trials	Meta analysis of RCTs	2	High	Good methodology Search criteria, research questions and null hypothesis clearly identified. RCT's included are assessed for their quality. Clear Conclusions are drawn.	Low number of RCT's identified Only 5 studies included from 2008 to 2014 due to strict exclusion criteria. Only 1 study followed CONSORT guidelines by Cochrane for RCTs
Buser, Martin *et al.* 2004[55]	Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations.	Case Study and Cinical recommendations	4	Moderate	Relevant to complexity and supported by case based discussion.	Low quality evidence as specialist opinion regarding treatment. Not a systematic review, and doesn't specify how references cited were identified. Potential for Author Bias.

Table 2 Assessment of the key articles supporting the indices (cont. from page 617)

Assessment of supporting literature						
Authors/year/ citation	**Title**	**Type of Study**	**Sacketts Hierarchy of Evidence**	**Relevance**	**Strengths**	**Weaknesses**
Ma and Fenton, 2015[68]	Screw- versus cement-retained implant prostheses: a systematic review of prosthodontic maintenance and complications.	Systematic Review	1	Moderate	Broad assessment of literature according to predefined criteria.	Only 6 RCTs and lack of comparable equivalent data regarding screw retained or cement retained restorations. Only 2 studies showed standardised criteria for reporting complications.
Morton and Ganeles 2008[69]	ITI Treatment Guide Vol 2 - Loading Protocols in Implant Dentistry Partially Dentate Patients	Treatment Guide	2-4	High	A broad assessment of available literature which was used as a basis for a consensus conference of experts. The proceedings of the conference were used to establish the SAC classification as a practical tool kit which can be used to assess complexity of cases.	Not a systematic review. No methodology indicated in reaching evidence base. Does not address the question of bias. Evidence from 2009 onwards not addressed.
Misch, CE 201[52]	Dental Implant Prosthetics	Book	4	High	Broad spectrum text, well referenced throughout.	Sole author bias may exist.
Koyano and Esaki 2015[32]	Occlusion on oral implants: current clinical guidelines	Narrative Literature review	2	Moderate	Aims to ascertain the influence of implant occlusion on the occurrence of complications of implant treatment and discuss the clinical considerations focused on the overloading factors at present. Strengths: Well presented Clearly stated aims, objectives and research methodology.	Unable to draw conclusions due to a lack of relevant well designed papers. Further research requirement identified.
Bragger, Heitz-Mayfield 2015[33]	Biological and Hardware Complications in Implant Dentistry	Treatment Guide	2-4	High	A broad assessment of available literature which was used as a basis for a consensus conference of experts. The proceedings of the conference were used to establish the SAC classification as a practical tool kit which can be used to assess complexity of cases.	Not a systematic review. No methodology indicated in reaching evidence base. Does not address the question of bias. Evidence from 2009 onwards not addressed.
Malo, de Araújo Nobre et al. 2011[64]	A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up	Prospective Longitudinal Study	4		10 year follow-up with good patient cohort.	Single Centre study Not a RCT so author bias is likely (Higgins, Green 2011) Not a systematic review
BDIZ EDI 2012[5]	Cologne ABC Risk Score	Consensus Conference	2	High	Good, simplified overview of risk assessment. Consensus conference providing peer assessment of selected literature. Quality of literature used is discussed Recommendations based on current evidence. Assessment tool provided. Low risk of bias.	Small number of references Lack of RCTs to draw on evidence base Lack of discussion in the form of a clinical guide from which to discuss factors which affect a particular case.

Aesthetics

Aesthetically replicating a natural tooth is of particular importance when in the aesthetic zone. This was defined at the 'Third ITI Consensus Conference: Esthetics in Implant Dentistry' as 'any dentoalveolar segment that is visible upon full smile, or has esthetic importance to the patient'.[12] Most people show over 75% of their incisors and interproximal gingivae,[13] therefore anterior implant treatment is considered to be more complex.[4]

Belser, Buser and Higginbottom define aesthetic restorations as being in harmony with the peri-implant tissues, including tissue health, volume, contours and colour.[14] They propose that replacing single teeth without tissue deficiencies can be achieved predictably with implants. Aesthetically challenging cases, replacing soft tissue, and replacing multiple adjacent teeth is more complex.[11]

A systematic review reported that restoring multiple implants further complicated treatment, and this is associated with increased implant loss following loading.[15] This was also reported by Salvi and Brägger who found greater complications with longer supra-structures, though this study was much less robust[16].

Intra-arch distance and edentulous space

Consideration must be given not only to the complexity of fabricating the prosthesis, but also to long term maintenance. Mandibular implant retained overdentures are straightforward to restore[17] but have a greater risk of long term complications compared with fixed reconstructions,[15] although these tend be of a lesser severity.[11]

Splinting implants for overdentures may again increase the complexity of the restorative treatment, however a systematic review has shown splinted implants have lower maintenance requirements.[18]

Reduced inter-arch distance may necessitate the creation of the 'ideal' space, complicating treatment.[2,6] In a situation with limited vertical height, the selection of a 'bone level' implant may allow for increased restorative options due to the prosthetic components and increased flexibility in the positioning of the prosthetic margin. This makes the treatment less complicated.[6]

In the case of the edentulous arch, space availability may dictate the restoration of choice. Carpentieri *et al.* concluded that, with space of less than 10 mm, a fixed prosthesis would be highly indicated; with space of greater than 15 mm, a removable prosthesis would be preferrable.[19] The type of restoration has a direct impact on the level of complexity.

Provisional restorations

Excessive inter-arch space may result in an aesthetic compromise. In the aesthetic zone there may be a requirement to prosthetically replace the missing hard and soft tissues, directly affecting the level of complexity.[2,6] Pink porcelain may be used to mimic the gingival position, although an aesthetic compromise may still result.

Restricted or increased mesio-distal space complicates treatment. This leads to difficulties in developing contact points, emergence profile, contouring of the prosthetics material, and symmetry. If there is asymmetry of more than 1 mm between contralateral central or lateral incisors, or canines, adjunctive treatments may be required in order to achieve an acceptable aesthetic result.[6]

Soft tissue

The soft tissue position is dictated by the underlying bone.[20] Identifying the tissue biotype helps predict the potential for soft tissue loss; thin biotypes, with highly scalloped gingival margins and prominent papillae, are more prone to tissue loss following extraction.[21] Square teeth are associated with thicker biotypes,[22] simplifying treatment as less soft tissue infill is required.

A distance of below 5 mm between the contact point and the bone is conducive to soft tissue infill.[23] Furthermore, Grunder suggests that the restorative status of the adjacent tooth is the critical factor in dictating papilla height,[24] unrestored teeth offering the most predictable prognosis. Adjacent implants, on average, only achieve 3.4 mm (from the bone to the contact point) of tissue infill as reported by Tarnow, thus optimising aesthetics in these cases is more complex.[25]

The presence of keratinised tissue around an implant is important for peri-implant health. Clinical studies have shown increased bone loss and decreased soft tissue health when keratinised tissue is thin or absent, it therefore follows that the lack of keratinised tissue increases the complexity.[26,27] The evidence base for these conclusions is low.

Morton *et al.*'s consensus statement suggests soft tissue augmentation can be effective in replacing lost tissue,[28] however the need for soft tissue grafting increases complexity. Systematic reviews by Rotundo *et al.*[29] and Poskevicius and Galindo-Moreno[30] both illustrate soft tissue gains are possible at the time of implant placement, but highlight that tissue loss does occur with remodelling.

Occlusion

The incisal relationship effects complexity: a complete overbite, significant overjet or retroclination increases complexity. This leads to the potential for adverse horizontal forces on abutment components.[6] Severe malocclusion can lead to the need for adjunctive orthodontic or restorative therapy before embarking on implant treatment; if left untreated, this can lead to mechanical complications due to non-axial loading or the ability to apply excessive force to the restoration.[6,31] In contrast Koyano and Esaki, found limited evidence to advocate a particular occlusal scheme.[32]

Parafunctional forces increase the risk of complications due to the application of excessive force.[2] In addition to this, the reduced proprioceptive feedback from a restored dental implant can lead to up to four times greater loading of an implant-supported restoration compared with a natural tooth.[2,32,33] The presence of parafunctional activity may necessitate a reduced occlusal table width, avoidance of non-axial forces, and the use of an occlusal splint.

There is an increased complexity when providing full-arch prostheses and bilateral free end saddles when compared with single tooth restorations.[34] Cantilevered restorations, which can place considerable off-axis force on an implant, present a significant technical risk factor.[35] Brägger's findings are supported by Pjetursson's meta-analysis.[36]

Human factors

A key factor influencing the complexity of treatment is the clinician.[6] The role of the clinician is to assess, investigate, diagnose, and advise the most appropriate treatment options. They then are required to carry out treatment to an appropriate standard of care, while continually ensuring that the patient is fully informed and able to consent to the treatment provided.[6]

Complex cases often involve a multidisciplinary approach. The use of protocols and tools, such as those discussed, aimed at identifying high-risk or complex cases can aid clinicians in accurately assessing these cases at an early stage.

Team communication

There is a causal relationship between communication and complications.[37] Effective communication can prevent active errors and reduce complexity. Team briefings play a vital role,[37] as does the implementation of customised safety checklists and creating opportunities 'for all team members to speak up and exchange information'.[38] A non-prejudicial environment for all professionals to voice concerns further improves safety and reduces complexity.[39]

A method for reporting errors is paramount and provides the best tool for exposing their cause, thus enabling action to be taken and lessons learnt.[37] An implant log, as recommended by the GDC,[3] is a valuable tool that may be used by the operator for reflective analysis and learning.

Eradicating human error is not possible but can be managed. Belser *et al.* advocate systematic therapeutic protocols to develop the highest degree of predictability.[11] A thorough treatment plan therefore should provide a comprehensive step-by-step guide from assessment through to treatment completion and maintenance, thus assessing and managing its complexity.[40] Furthermore, it should minimise the incidence of unanticipated outcomes, thereby simplifying treatment in the subsequent stages of restoration and maintenance.

Afsharzand highlighted the frequency of poor communication between the dentist and laboratory, which inevitably leads to increased treatment complexity.[41]

Systemisation provides defences, barriers and safeguards against error, thereby reducing complexity.[42]

Work environment

There are many elements conducive to providing a properly functioning work environment. Training and development has traditionally been viewed as fundamental to reducing error and complexity: 'Education has traditionally been based on the assessment of technical proficiency rather than human interaction'.[43] The GDC's new curriculum framework document recognises leadership and team work as core education.[44]

Formal and appropriate training is a vital and a necessary requirement.[45] However, training is only one aspect that enables clinicians to assess complexity. Ongoing evaluation and appraisal builds a strong working environment, providing support to all team members.

Technical factors

Impression techniques

Impression taking and casting must be accurate; any errors will complicate the fitting of the prosthesis.[46] Correct selection and seating of impression copings is critical with evidence suggesting open tray impressions are most accurate.[47] The magnitude of inaccuracies multiplies with each additional implant, thus increasing the complexity, an effect further compounded by distortion when constructing the suprastructures.[48]

Ill-fitting suprastructures may be non-passively seated on implants, possibly causing long term complications such as screw loosening[49] or potentially bone loss.[50] Passivity therefore must always be checked; the Sheffield Test[51] can help, but is relatively subjective. Splinting impression components together while taking impressions reduces errors[47] but distortion of the splinting material must also be considered.[52]

Modern digital impressions are quicker and simpler than conventional impressions[53] and eliminate model casting, although there is currently no strong *in vitro* evidence in favour of their accuracy.[47]

Provisional restorations

Provisional restorations play a key role in maintaining and developing soft tissues.[20] It is clear that the need to use provisional restorations increases the level of restorative complexity. Removable appliances are easier to fabricate than fixed provisionals[4] although the latter may allow for better tissue management and ultimately a more aesthetic definitive restoration.[54]

The use of provisional restorations varies between cases, and in some cases, no provisional restoration is required at all. Belser, Martin *et al.* concluded that inappropriate or non-use of provisional restorations may lead to aesthetic complications.[12]

If there is a need to use provisional restorations to develop symmetry of the hard and soft tissues and a 'natural appearance' of the papilla between prosthetic teeth, then this increases the complexity.[6,55] In the case of replacement of multiple missing teeth, a lack of adjacent teeth results in the need for alternative methods to create the appearance of natural papillae. This may include tissue-shaping with provisional restorations, ovate pontics and the use of pink porcelain.[6,55] The junction between the prosthesis and mucosa may present further aesthetic challenges, and may be acceptable or unacceptable dependent on whether this area is seen during normal function or smiling, this in turn has a bearing on the level of complexity.

Type of retention

The prostheses can be definitively restored with either screw or cement retention. Shadid and Sadaqa provide a useful overview of retention although this is low level evidence due to their non-systematic selection of literature.[50] This study suggests that the depth of the restoration margin below the gingivae must be considered for a cemented prosthesis to enable removal of excess cement.[56] If this is not achieved, it can lead to peri-implant inflammation.[56]

Screw retention is safer for deeper margins and gives the optimal marginal fit.[57,58] This is not always suitable due to the position of the screw access channel, which compromises the occlusal integrity of the crown. Screw retention is arguably more complex and raises concerns about passivity for larger reconstructions; however retrievability is often cited as its overriding benefit.[14]

Wittneben, Millen and Brägger researched articles in multiple languages from a broad spectrum of clinical settings with a strict inclusion and exclusion criteria. Their review also contained meta-analysis with a long follow-up, and they found fewer technical complexities and biological complications with screw retained prostheses than cemented ones. Implant survival was not significantly different.[59]

Each case must be assessed individually; however both cement and screw retention increase the complexity of implant restoration or maintenance if incorrectly utilised.

Loading protocol

Dental implants can be restored immediately (within one week), early (within two months) or conventionally (after two months).[60] Emerging evidence suggests immediate loading is appropriate when adequate primary stability is achieved.[60,61]

Moraschini *et al.* conducted a meta-analysis of RCTs looking at immediate or conventional loading of single implants in the posterior mandible. They concluded that there was no significant statistical difference between immediate and conventional loading of dental implants. However, the development of a large number of RCTs was required in order to monitor immediate loading techniques.[62]

There is significant heterogeneity regarding the timing of immediate loading and the quantity or measurement of primary stability. Without a clear consensus and evidence, immediate loading is still unpredictable and as such, is considered to greatly increase treatment complexity.[4] Immediate loading should only be attempted by experienced clinicians;[63] conventional protocols should be followed in practice while the clinician is inexperienced.

Early loading in the edentulous maxilla is considered to be more complex than in the mandible, primarily due to the relatively increased volume of cortical bone in the mandible.

Evidence is emerging for the immediate restoration of the edentulous arch using a splinted, passive-fitting restoration, however the complexity associated with planning, fabrication and delivery of such a prosthesis is considered to be high.[6,63]

Conclusions

A thorough understanding of complexity is of particular importance for the inexperienced clinician, who must be able to scrutinise their own competence in providing treatment, know when to refer a patient, and when to seek additional mentoring.

There are many interconnecting factors which affect the complexity of dental implant restoration, and these have been explored in this paper. Furthermore the two widely used indices for the assessment of complexity have been investigated, and although these offer a good guideline as to the level of complexity,

Table 3 Guidance to reduce complexity in dental implant restoration

Patient factor	Guidance to reduce complexity level
Expectation	Modify to ensure achievable realistic expectations. Give sufficient information for thorough patient understanding.
Communication	Clear and concise. Thorough documentation, with written documentation to patient.
Oral Environment	Healthy dentition and oral environment prior to treatment. Reduce risk factors, in particular periodontal risk factors and bruxism. Thorough assessment of current dentition, in particular adjacent teeth: Virgin teeth, teeth in a poor condition, and teeth with an unfavourable emergence increase complexity – compromised aesthetic outcomes are to be discussed with the patient.
Aesthetics	Thorough investigation of expectations and discussion of aesthetic outcomes, in particular, if lip and smile line and the quality and quantity of soft tissue are unfavourable. Measure mesio-distal space, and assess papilla. If compromised or asymmetric, investigate this with the patient. Assess mouth opening. Consider prosthetic design, smaller bridge units are less complicated than larger spans.
Intra arch and edentulous space	Consider restoration type – overdentures are less complicated than fixed prosthesis, however have more complications. Consider splinting implants for overdentures – more complex treatment, however fewer complications.
Soft tissue	Pre-operative assessment of biotype and tooth shape. Square teeth and thicker biotypes are less complicated. Tapering shaped teeth and thin biotypes require compromised aesthetic outcomes to be discussed with the patient. Assess papilla, height of the contact point (ideally <5 mm from bone), emergence, and presence/absence of keratinised tissue. If unfavourable consider compromised aesthetic outcome, or soft tissue augmentation.
Occlusion	Complete overbite, significant overjet and retroclination may increase the complexity. Patient to be advised of possible complications. Avoid cantilevered restorations if possible. Control parafunction.
Human factor	**Guidance to reduce complexity level**
Team communication	Use check lists. Encourage team to speak freely and exchange information. Method for reporting errors. Carryout reflective analysis and an implant log. Ensure good communication with laboratory. Systemisation and standardisation of protocols.
Work environment	Adequately trained team. Ongoing evaluation and appraisal.
Technical factor	**Guidance to reduce complexity level**
Impression technique	Ensure accurate impressions and casting. Use open tray impression copings. Splint impression copings together if multiple units. Ensure passivity of superstructure.
Provisional restoration	Thoroughly assess the need for a provisional restoration and only use where appropriate. Removable provisional restorations are less complicated however fixed provisional restorations give ultimately a better aesthetic result. Consider the use of pink porcelain.
Type of retention	Comprehensively assess the case and use the most appropriate type of retention. Screw retained is arguably more complex, however has fewer complications than cement retained restorations.
Loading protocol	Immediate loading is more complex than delayed and should be avoided by inexperienced clinicians. Early loading is more complex in the maxilla.

there is a lack evidence to support their use. Based on the findings of this paper a practical guide to aid practitioners in reducing complexity has been proposed (Table 3).

The development of evidence-based treatment and protocols is necessary to further develop the current indices, and these need to be expanded to include other critical areas, such as human factors.

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