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The BIO–MECH–ESTH–MAINT Model: A Structured Decision-Making Framework for Implant Prosthesis Retention

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ABSTRACT

Background

The selection of retention mechanisms for implant-supported restorations remains a topic of ongoing debate in prosthodontics. Although both systems show similar survival outcomes, they present distinct complication patterns and maintenance requirements. The current literature presents a descriptive comparison of advantages and disadvantages, offering limited guidance for structured, reproducible clinical decision-making.

Purpose

The aim of this article is to propose a structured, clinically applicable, risk-based framework to guide clinicians in selecting the most appropriate implant prosthesis retention method.

Methods

A narrative review of the literature was conducted, addressing biological, mechanical, esthetic, and maintenance considerations associated with implant prosthesis retention. Based on current evidence and clinical principles, a conceptual decision-making model was developed.

Results / Framework Description

The BIO–MECH–ESTH–MAINT (BMEM) framework integrates biological risk, mechanical considerations, esthetic demands, and long-term maintenance requirements, enabling clinicians to evaluate patient- and case-specific risks and select the most appropriate retention strategy.

Conclusion

This framework offers a structured and reproducible method for implant prosthesis retention selection. Emphasizing biological safety, retrievability, and long-term maintenance, this model provides evidence-informed decision-making and may enhance clinical outcomes. Future prospective studies are recommended to validate its clinical effectiveness.

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Keywords -Screw-retained restorations; Cement-retained restorations; Peri-implant disease; Clinical decision-making

INTRODUCTION

The introduction of dental implant has revolutionized prosthodontics treatment of partially and completely edentulous space with predictable success rate and excellent patient acceptance.[1, 2] Improvement in implant design and materials, prosthetic options have increased the possibilities to achieve a successful and stable treatment outcome [3].

Early implant prostheses were predominantly screw retained restoration, primarily in response to the need for implant supported restoration retrievability and maintenance[4]. While cement retained restoration became popular because its clinical and laboratory procedures are very similar to those used for traditional tooth-supported restorations, making it more familiar to many practitioners, superior esthetics by creating lifelike contours and surface characteristics, improved passivity of fit, reduced costs and chairside time, and compensate for non-ideal implant angulation [5, 6].However, clinical challenges of screw retained restoration include; frequent screw loosening, difficulties in achieving passive fit, and screw access holes which may compromise aesthetic [7] . nevertheless, the most significant drawback of cement retained restoration is the risk of residual excess cement being trapped in the peri-implant tissues, which is a major risk factor for peri-implant mucositis and peri-implantitis. Furthermore, cement-retained restorations are generally regarded as irretrievable; in the event of any complication associated with cement retained restoration like abutment screw loosening, crown removal often may require irreversible destruction of the restoration to regain access.[8-11].

Screw retained and cement retained implant restoration have been widely compared in literatures and clinical study, with respect to survival rates, marginal bone loss, esthetic outcomes, and prosthetic complications.[3, 6, 12] . While there is no significant difference in term of survival rate, differences have been reported in their biological and technical complication profiles [13, 14]. Despite the controversy in literature both retention methods have been extensively adopted in clinical practice.[15-17]

Selection of prosthesis retention mechanism reported in many Systematic reviews and consensus is a crucial decision and based on various factors including clinical requirements, esthetic demands, and operator preferences [14] [18, 19], furthermore most publication address the selection criteria based on advantages and disadvantages in a descriptive manner without offering a structured, reproducible decision-making approach[3, 5, 20, 21]. Therefore, there is a need for comprehensive risk-based framework that combines a biological, mechanical esthetics and maintenance consideration into single decision-making model. The aim of this articles to present a clinically applicable, novel framework to guide

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selection criteria between screw retained and cement retained implant restoration in current prosthodontic practice.

Description of the BIO–MECH–ESTH–MAINT Framework

The BIO–MECH–ESTH–MAINT (BMEM) framework is a multidomain-based decision-making model designed to guide the selection of implant prosthesis retention by integrating of biological, mechanical, esthetic, and maintenance-related risks. This approach aims to simplify complex clinical variables into repeatable strategy without restricting clinician judgment.

Biological Considerations

Success of a dental implant restoration is widely attributed to a combination of factors related to the patient's health and habits, the surgical procedure, and the characteristics of the implant and restoration[22]. Many literatures advocate that the presence of healthy peri-implant soft-tissue acts as a biological barrier against microbial invasion and subsequent bone loss[23, 24]. The attachment mechanism of pre-implant tissue shows some difference as compared by natural teeth; the key difference is that the collagen fibers run in parallel orientation in relation to the implant resulting in reduced cellularity and vascularity in peri- implant tissue. losing of this physical barrier will result in bacterial invasion and limits the progression of periodontal disease[25, 26]

Despite proven advantage of cement retained implant restoration, the excess cement retained in sulcular tissue remain the drawback to choose this type of restoration. Excess cement acts like an artificial calculus and endangers the health of dental implants and adjacent soft tissues[27], Moreover, residual cement is more frequently associated with deeper subgingival abutment margins, where detection and removal become increasingly challenging. [7, 28-30]. Consequently, patients with a history of periodontal disease, compromised oral hygiene, or increased susceptibility to peri-implant inflammation may be at higher biological risk when cement-retained restorations are used[8]. On other hand screw-retained restorations show low risk of biological complication by eliminate the remnants cements and allow retrievability for maintenance and peri-implant tissue evaluation[13, 31] .From a biological standpoint, screw retained restoration is wise choice in patients with elevated biological risk, deep restoration margin or thin tissue biotype[32].

Mechanical and Implant Position Factors

Another factors which must be considered in selection criteria for implant supported restoration is mechanical and implant position factors; including implant angulation, prosthetic fit, occlusal loading, and available restorative space.

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A passive fit is essential for implant restorations because osseointegrated implants lack the physiological mobility of natural teeth, and failure to achieve this results in a misfit prosthesis.[33] A misfit prosthesis may lead to problems such as screw loosening, fracture of the prosthodontic component or even of the implant itself, and bone loss around the implants[34]. While screw-retained restorations can be verifying for passive fit using several clinical assessment methods [35] many authors suggested that cement-retained restorations can provide improved passive fit, as the intervening cement layer—approximately 40 µm in thickness—may compensate for minor discrepancies and act as a shock absorber, reducing stresses transmitted to the supporting bone. [15, 19]

Screw retained restoration is indicated in cases where implant position and angulation were adequately planed with screw access hole positioned on the palatal or occlusal surface of restoration without compromising function or esthetics[36]. Whereas a cement retained restoration are favor when dental implant angulation and position is not ideal and permit the access hole to be position in incisal or facial surface which compromise esthetics.[6] However, recent advancements in angulated screw channel technology have made it possible to employ screw-retained restorations in implants with angulations approaching 30°[37].

Ideally implant should be placed under the central fossa of posterior teeth to generate axial loading and dental implant restoration should provide stable occlusal contacts[4], considering screw retained restoration presenting a drawback in context of occlusal area mainly in posterior teeth. stemming from screws holes are ±3 mm in diameter and the occlusal table for premolars and molars teeth approximately 5 mm and 6 mm respectively, which mean that 50% or more of the intercuspal occlusal table required to be covered by restorative materials which are less durable as compared to full coverage restorations. [5, 19] in addition to that the screw access hole may interferes with protrusive and lateral excursions and, therefore, anterior guidance may be compromised[15]. Since the cement-retained restorations devoid of access hole, uniformity of occlusal table provides precision of occlusal surface that creates more homogenous load distribution during function[38].

Interocclusal space is another important factor need to be considered, surface area and height influence the amount of retention in dental implant restoration[39]. Screw-retained restoration is indicated in cases where interocclusal space is limited i.e., <4 mm while the minimum abutment height to use cement-retained restorations with predictable retention was documented to be 5 mm[15].

Esthetic Considerations

One of main objective of dental implant is achieving highly esthetic restoration, its challenging task since it depends on multiple factors including implant position, smile line, shape and contour of adjacent teeth, biotype of the periodontium[40].

Power System Technology
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Cement retained restoration is generally considered the standard for achieving optimal esthetics. The absence of a screw access opening allows for uninterrupted crown morphology and surface characteristics, contributes to superior esthetic outcomes, particularly in the anterior region.[21] Consequently, cement retention has traditionally been preferred in situations where implant angulation would cause a screw access hole to emerge on the facial or incisal aspect of an anterior restoration. [19].

Screw retained restoration has functionally advantageous in term of retrievability, presence of screw access hole in restoration is could compromise esthetics if it's not properly restored or positioned[41]. Advancements in restorative materials, composite masking techniques, Implant Crown Adhesive Plug, angulated screw channel technology have reduced the esthetic drawbacks of screw-retained restorations.[15, 42], however placing a temporary screw retained restoration immediately after surgery provides instant esthetics and allows for shaping the gums over time to achieve a natural contour for the final restoration[6, 43]. Nonetheless in maxillary anterior region, a highly demanding aesthetic zone cement retained restoration may be highly considered especially when biological and mechanical risk are low

Maintenance and Retrievability

Retrievability and the long-term maintenance are crucial requirements to be considered when choosing retention system for dental implant restoration, since implant-supported restorations are susceptible to biological and mechanical complications over time, and non-destructive access is often required for effective management, repair, and monitoring of peri-implant health.

Screw retained restoration support the concept of retrievability which allows for the non-destructive removal of the prosthesis. This feature facilitates tightening of loosened abutment screws, repair of fractured components, calculus removal, and management of biological complication by evaluating implant and soft tissue. This is particularly recommended in complex prosthetic designs (Large, full-arch implant reconstructions, Cantilevered prostheses), and in patients who are at a high risk of developing gingival recession, or are expected to lose more teeth in the future[5, 6, 15]. Accordingly, patients should be enrolled in a well-structured maintenance system, with professional evaluations typically recommended every 4 to 6 months. This frequency may be increased to every 3 to 4 months for high-risk patients, such as those over age 60, smokers, or those with a history of periodontal disease[44]

In contrast, cement-retained restorations are generally considered irretrievable. In many cases, if removal is required to address a biological or mechanical complication these restorations must be destroyed by sectioning which is a time consuming and uncomfortable for the patient, therefor increase the clinical complexity and cost.[6, 15] Therefore, when

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long-term maintenance or future intervention is anticipated, screw retention should be strongly considered.

Discussion

The selection of retention mechanism for implant-supported restoration remains a subject of ongoing debate in the literature, although many studies describe the advantages and disadvantages of each retention method, recommendations are often presented in isolation and without a structured, clinically applicable decision-making model [5, 6](TABLE 1). Recent developments in dental implant prosthetic materials and design have enhanced retention selection flexibility by providing solutions to address the individual shortcomings of screw-retained and cement-retained systems in specific clinical scenarios. (TABLE 2)

The proposed BIO–MECH–ESTH–MAINT(BMEM) framework aims to integrate multiple clinically relevant domains into a unified, risk-based decision model. By prioritizing biological risk consideration (BIO) by assessing peri-implant tissue health, history of periodontal disease, oral hygiene status, tissue biotype, and restoration margin depth. Higher biological risk favors screw-retained restorations to eliminate cement-associated complications and facilitate monitoring. Mechanical and positional factors (MECH), includes implant angulation, prosthetic fit, occlusal loading, interocclusal space, and restorative space availability. Favorable implant positioning and limited interocclusal space support screw retention, whereas non-ideal angulation or need for contour correction may favor cement retention. Esthetic considerations (ESTH), are addressed as an independent domain, evaluates smile line, emergence profile requirements, and visibility of screw access. High esthetic demand, particularly in the anterior zone with unfavorable screw access, may favor cement-retained restorations when biological risk is low. A key strength of this framework is its focus on long-term maintenance and Retrievability (MAINT), considers the likelihood of future intervention, complexity of the prosthesis, patient risk factors, and long-term maintenance needs. Situations requiring retrievability strongly favor screw-retained restorations (TABLE 3)

The BIO–MECH–ESTH–MAINT framework consider as a practical tool that guiding the clinician in daily clinical decision-making while choosing implant retention system by systematically assess risks, justifying the treatment choices based on patient- and case-specific factors, may improve patient outcomes through reduced biological and technical complications, enhanced maintenance accessibility, and more predictable long-term performance of implant restorations.

Nevertheless, this framework formulated based on a narrative review of the literature, which may be subject to selection bias and does not provide quantitative synthesis of outcomes. Assessment of each domains involves a degree of clinical judgment, which may introduce

Power System Technology
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subjectivity. Furthermore, the framework has not yet been validated through prospective clinical studies. Therefore, the framework should be applied as a guiding tool rather than a prescriptive protocol.

Table 1: CLINICAL INDICATION THAT PREFER SCREW RETAIND RESTORATION VS THOSE THAT PREFER CEMENT RETAINED RESTORATION

Screw retained retention	Cement retention may be recommended
Large, full-arch implant restorations	Single-unit, Short-span prostheses with margins at or above the mucosa level
FDPs with a cantilever design	To compensate for improperly inclined implants
In esthetic zone, for provisionalization of implants	Narrow-diameter crowns
When retrievability is desired	To reduce initial treatment costs
Patients at high risk of gingival recession	Limited mouth opening
Minimal interarch space (minimum 4 mm)	
Patients who are expected to lose their teeth in the near future.	
Elimination of excessive cement is challenging (final restorative margin extends more than 3 mm subgingivally)	

TABLE: 2 Common Drawbacks of Screw-Retained and Cement-Retained Implant Restorations and Corresponding Clinical Management Strategies

SCREW RETAINED RESTORATION DRAW BACK	CLINICAL METHODS TO SOLVE IT
Screw loosening and/or screw fractures	1- Using the original components of implant system.[45] 2- Screws should be torqued to the manufacturer's specifications.[4] 3- Retorquing the screw 5 minutes after initial torquing and again a few weeks later is recommended (Screw settling)[5]

Power System Technology
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	4- Using the implant systems that employ a conical interface between the implant and the abutment.[5]
Compromise esthetics/ Large screw access hole	1. Use an opaque material combined with resilient composite.[3] 2. Implant Crown Adhesive Plug (ICAP).[42] 3. Angulated screw channels (ASCs), repositioning of the screw access point within a range of up to 30° from the implant axis in any 360° direction ([36]
Passive fit	1. Apply Sheffield test (one-screw test) visual assessment, tactile perception of the misfit with a dental explorer. 2. Evaluation of the framework fitting used radiographic image. 3. Torque-controlled surgical motors can record torque/time graphs during tightening to identify potential misfits objectively[35]
Porcelain fracture	Mechanical Protection: In areas of high occlusal load, using metal occlusal tables or monolithic materials like zirconia can prevent the porcelain chipping that often occurs around the edges of the screw access hole

CEMENT RETAINED RESTORATION DRAW BACK	**CLINICAL METHODS TO SOLVE IT**
Excess cement	1. Extraoral Cementation (A copy abutment or analog)[43, 46]. 2. Rubber Dam/Barrier: Employ a rubber dam or temporary materials to block subgingival cement migration. 3. Abutment and Margin Design: A. Restoration-abutment interface should ideally be placed 0.5 mm to 1 mm submucosally, and in no case deeper than 1.5 mm. B. Custom abutments are preferred over stock abutments because they can follow the gingival contour and reduce deep undercuts that trap cement[43] 4. Venting Techniques: Creating an occlusal or lingual vent hole

Power System Technology
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	in the crown allows excess cement to escape coronally through the hole rather than being forced into the subgingival sulcus[47] 5. Seating Protocols: Clinicians should use lower crown seating speeds and controlled force during cementation. Rapid seating can build hydraulic pressure, forcing low-viscosity cements deeper into the peri-implant tissues[25] 6. Applying petroleum jelly, using curettes, and flossing during crown cementation
Retrievability	1. Lingual set screw[48] 2. Use temporary cements (e.g., zinc oxide-eugenol) for better retrievability. 3. Stain markers to identify the location of the underlying abutment screw for precisely targeted perforation[5, 6]

Table 3. Proposed Risk-Based Framework for Selecting Implant Prosthesis Retention

Decision Domain	Clinical Considerations	Screw-Retained Preferred	Cement-Retained Preferred
Biological Risk (BIO)	Periodontal history, peri-implant tissue health, hygiene level, soft-tissue biotype	History of periodontitis or peri-implantitis; thin biotype; deep sulcus; high plaque risk; concern about cement remnants	Low biological risk; thick biotype; shallow margins; excellent oral hygiene
Mechanical & Implant Position (MECH)	Implant angulation, screw access position, interocclusal space	Favorable implant alignment; screw access on occlusal/lingual surface; availability of angulated screw channel (ASC); limited vertical space	Severe implant angulation without ASC; screw access compromises crown integrity; adequate vertical space
Esthetic Demand	Smile line, crown translucency,	Posterior region; screw access can be	Anterior esthetic zone; high smile

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(ESTH)	esthetic zone	masked; esthetics not critical	line; need for uninterrupted ceramic surface
Maintenance & Retrievability (MAINT)	Risk of complications, need for future access	Bruxism/parafunction; anticipated maintenance or repair; long-span restorations; medically compromised patients	Low functional risk; single-unit restorations; retrievability not a priority

Decision Rule:
If **≥3 domains favor screw retention**, select a **screw-retained restoration**.
If **≥3 domains favor cement retention**, select a **cement-retained restoration**.
If evenly balanced, consider **hybrid (screw-cement-retained) designs** or **ASC solutions**.

Conflict of interest

The authors declare no conflict of interest.

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Regulatory Statement

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