RESEARCH PAPER

The Rosen Screw and Titanium-Base-Free Abutment Screw Systems: A Narrative Review of Screw Biomechanics, Titanium-Base Abutments, and Clinical Evidence

Rupesh Bhoir[1*], Dr. Aditi Sarda[2], Himanshu Srivastava[3], Mempally Hari Kumar[4], Rohan Ranveer[5], Sunita Yadav[6]
[1]3rd PG, Department of Prosthodontics and Crown and Bridge, Aditya Dental College, Beed, Maharashtra, India
[2]Reader, Department of Conservative Dentistry and Endodontics, Aditya Dental College, Beed, Maharashtra, India
[3]Professor, Department of Oral Pathology and Microbiology, Aditya Dental College, Beed, Maharashtra, India
[4]Professor & HOD, Department of Prosthodontics and Crown & Bridge, Aditya Dental College, Beed, Maharashtra, India
[5]Reader, Department of Prosthodontics and Crown & Bridge, Aditya Dental College, Beed, Maharashtra, India
[6]2nd PG, Department of Prosthodontics & Crown and Bridge, The Oxford Dental College, Bengaluru, Karnataka, India
***Corresponding Author:** Rupesh Bhoir, Department of Prosthodontics and Crown and Bridge, Aditya Dental College, Beed, Maharashtra, India
Email: Rupesh456bhoir@gmail.com

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ABSTRACT

Screw-retained implant prostheses depend on a small threaded joint that must hold its clamping force through years of cyclic loading. In multi-unit abutment (MUA) and digital CAD/CAM workflows, this joint has traditionally been paired with a bonded titanium base (Ti-base), which adds a resin-cemented interface with its own risk of debonding. Titanium-base-free screw systems, of which the Rosen Screw® is the best-known commercial example, remove the Ti-base and connect the milled prosthesis directly to the MUA through a conical-headed screw.

This narrative review summarises the PubMed-indexed literature relevant to that concept: the biomechanics of screw preload and loosening, the effect of screw-head geometry, the performance and limitations of Ti-base abutments, the emerging titanium-base-free MUA literature, and the wider screw- versus cement-retained evidence. Bench studies consistently favour conical and double-conical heads over flat heads for loosening resistance, and a micro-CT loading study found the highest failure loads in straight MUA assemblies, with angulation lowering failure load for both Ti-base and MUA assemblies. However, a 2026 critical review describes the evidence on titanium-base-free MUA connections as limited and fragmented, and no PubMed-indexed study identified here tests the Rosen Screw brand itself. The concept is mechanically reasonable, but long-term, product-specific validation is still missing.

Keywords: Rosen screw; titanium base; multi-unit abutment; abutment screw; screw loosening; preload; implant prosthodontics

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1. Introduction

Every screw-retained implant restoration rests on a threaded joint only a few millimetres wide. Tightening the screw stretches it slightly, and that elastic stretch, the preload, is what keeps the prosthesis pressed against the abutment or implant. When the preload is lost, the joint opens, the screw loosens, and the mechanical and biological complications that follow are well known. Screw loosening is among the most frequently reported mechanical complications in implant-prosthetic rehabilitation[1], and probabilistic modelling shows how fragile the starting point can be: even in a well-lubricated joint only about half of assemblies reach the intended preload range[2].

Digital dentistry has changed how this joint is built. In multi-unit abutment (MUA) restorations and single-unit CAD/CAM crowns, the milled restoration is commonly resin-bonded to a prefabricated titanium base (Ti-base), which is then screwed to the implant or MUA[3,4]. The approach combines the strength of titanium at the connection with the freedom to mill tooth-coloured or framework materials above it. Its weak point is the bonded interface, whose success depends on surface treatment, Ti-base height and cementation protocol[5,6].

Titanium-base-free systems try to remove that interface altogether. The Rosen Screw®, developed by Dr. Dan Rosen and sold in several diameters, is a conical-headed prosthetic screw that the manufacturer describes as allowing a milled prosthesis to connect directly to a multi-unit abutment without a Ti-base; other manufacturers market similar direct-to-MUA screws. These are manufacturer descriptions rather than published trial findings, and part of the purpose of this review is to ask how far the peer-reviewed literature supports them. The sections below move from the mechanics of the screw joint, through screw design and Ti-base abutments, to the titanium-base-free literature itself and the broader clinical evidence on screw retention.

2. Biomechanics of the Abutment Screw Joint

2.1 Preload and how it is lost

Early elongation measurements on UCLA-type abutment screws showed that the manufacturer-recommended torques (32 N·cm for gold-alloy and 20 N·cm for titanium screws in that study) stress the screw to roughly 57.5% and 56% of its yield strength respectively, so a working margin remains before plastic deformation[7]. Achieving that preload reliably is harder than it sounds. In a finite-element model with random variation in friction, material properties and applied torque, the probability of landing inside the target preload range was about 54% for a well-lubricated joint and only 0.02% for a dry one; the same analysis identified applied torque and the friction coefficient between screw threads and implant bore as the dominant variables[2]. The practical message is that lubrication, torque accuracy and screw material all shape the clamping force the joint actually receives.

2.2 Retightening and torque protocols

Preload is not permanent. Settling of the mating surfaces causes early loss, and retightening after the first tightening is the standard countermeasure. A classic in vitro study tightened screws to 25–40 N·cm, retorqued some groups after 10 minutes, and recommended routine retightening at that interval and torque values above about 30 N·cm[1]. A later systematic review of dynamic-fatigue studies on preload loss reached a compatible conclusion, identifying retightening as a positive factor for maintaining preload[8]. A comparison of four connection designs under cyclic loading found that loading significantly reduced removal torque, that multiple retightening produced higher removal torque than a single tightening, and that connection design itself did not clearly govern preload maintenance; the authors advised retightening a few minutes after insertion[9].

2.3 Cyclic loading and fatigue

Static torque data do not capture what happens over thousands of chewing cycles. Dynamic fatigue testing has been used to study joint opening at the implant–abutment interface in wide- versus standard-diameter hex-type implants[10], and cyclic air-cylinder loading devices have been used to analyse screw loosening as a function of load waveform[11]. In complete-arch mandibular frameworks, detorque values after cyclic loading depended on the implant position and on the sequence in which screws were tightened, whereas the physical appearance of the screws did not change measurably[12]. Repeated tightening and different screw types have also been compared for the preload they generate[13], and preload and removal torque have been measured for three abutment screw designs in single-implant restorations[14]. Taken together, these studies show that the screw joint is a fatigue problem as much as a tightening problem, which matters for any design, such as a titanium-base-free connection, that places the whole mechanical burden on the screw.

3. Abutment Screw Design

3.1 Screw-head geometry

Head shape is the design variable most relevant to the Rosen concept. In a study of 80 implant–screw–abutment assemblies loaded for 3,000,000 cycles, double-conical head screws showed significantly higher loosening torque than conical-head screws, and conical-head screws in turn outperformed conventional flat-head screws, both before and after loading[15]. A separate study fabricated screw and abutment pairs with 30°, 60°, 90° and 180° fitting tapers: larger tapers gave higher preload, but smaller tapers gave greater loosening torque and better resistance in dynamic tests, and loosening torque fell and screw stress rose as the loading angle increased from 15° to 45°[16]. The 2026 critical review of titanium-base-free connections summarises the same direction of evidence, noting that conical or tapered heads generally resist preload loss better than flat heads[17]. This is the mechanical rationale behind wedge-shaped screw heads such as the Rosen Screw, although none of these studies tested that specific product. Examples of the head designs in current use are shown in Figure 1.



Figure 1. Representative prosthetic screw designs used in titanium base-free multi-unit abutment restorations, showing differences in head geometry and overall configuration. Reproduced from Mosaddad et al.{{mosaddad}} (Materials, 2026; open access, CC BY).

3.2 Material and restorative height

The finite-element work on preload also suggested that screw materials with a higher elastic modulus can reach higher preload[2]. Restorative height matters as well: in titanium-base-free restorations a taller prosthesis needs a longer screw segment, which may lengthen the effective

lever arm and concentrate stress at the screw head–shank transition[17]. Figure 2 summarises how the two restorative pathways differ and where the main mechanical risk sits in each.

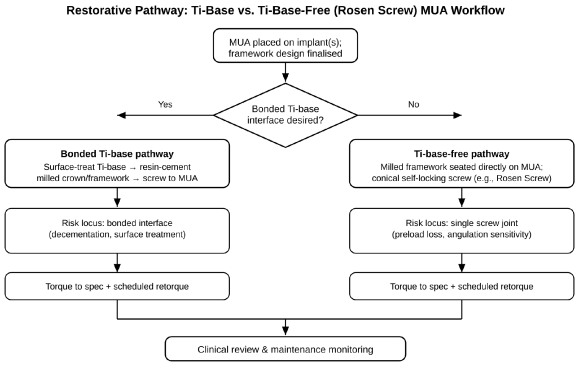


Figure 2. Flowchart of the bonded titanium-base pathway versus the titanium-base-free (Rosen Screw-type) pathway, showing where the principal mechanical risk sits in each. Prepared by the author from the literature reviewed.

4. Titanium-Base Abutments

4.1 Concept and overall performance

Titanium bases were introduced to combine the strength of a titanium connection with the aesthetic and design freedom of a milled ceramic or polymer restoration. A literature review of 33 studies through 2020 concluded that Ti-base abutments show high fracture strength, adequate retention (particularly with resin cement) and good marginal and internal fit in vitro, with short-term clinical performance comparable to conventional abutments in the anterior and premolar regions, but that long-term clinical data are needed[3]. A second review of 21 studies through 2021 covered misfit, screw loosening, retention and fatigue testing of prefabricated Ti-base systems and reported, among other findings, that taller Ti-bases gave greater retention of zirconia crowns[4].

4.2 Bonding, geometry and their limits

Because the restoration is cemented to the Ti-base, retention depends on how the bond is made. Airborne-particle abrasion of the Ti-base influenced the stability of the bonded interface and crown retention after artificial ageing[6], and the cementation protocol used for zirconia crowns on Ti-base CAD/CAM abutments has been studied specifically for the same reason[5]. Geometry also plays a part: one in vitro study compared six implant/Ti-base combinations with different gingival and prosthetic heights, restored with polymer-infiltrated ceramic network crowns, to examine how macro- and micro-geometry affect mechanical stability[18]. Together these papers show that a Ti-base restoration performs well when height, surface treatment and cementation are controlled, and that each of those variables is a point where the result can vary. The bonded joint is therefore both the strength of the workflow and the source of its distinctive failure mode, decementation.

5. Titanium-Base-Free Multi-Unit Abutment Connections and the Rosen Screw

5.1 The concept

Titanium-base-free MUA restorations were introduced to simplify the prosthetic workflow by eliminating the intermediate Ti-base and its bonding interface. The critical review by Mosaddad and colleagues points out that this changes the biomechanics of the prosthesis–abutment–implant complex and increases reliance on the prosthetic screw: preload maintenance, screw loosening and fatigue behaviour become the primary determinants of mechanical performance[17]. Removing a component does not remove the load; it moves it onto the screw. The difference between the three concepts is illustrated in Figure 3.



Figure 3. Schematic comparison of restorative connection concepts in implant-supported prostheses: titanium base-free design with direct prosthesis-to-abutment connection (left), bar-supported design with an intermediate framework (middle), and conventional titanium base-supported restoration on a multi-unit abutment (right). Reproduced from Mosaddad et al.{{mosaddad}} (Materials, 2026; open access, CC BY).

5.2 What is claimed for the Rosen Screw

Manufacturer and distributor material describes the Rosen Screw as a conical-headed screw, supplied in 1.4, 1.6 and 1.72 mm sizes and in a longer 1.4 × 3 mm version for Straumann straight MUAs, that seats into the MUA so that no Ti-base is needed, can be tightened by hand, and in some variants tolerates angulation up to about 30°. The critical review, summarising manufacturer information, adds that the screw is torqued up to 20 N·cm, is offered in variants such as Rosen Wave and Rosen SH, and is supported by digital libraries for CAD/CAM platforms[17]. These statements come from commercial sources and are not peer-reviewed findings. Their mechanical logic is consistent with the conical-head literature in Section 3.1, but the specific claims about hand torque, angulation and "never-loosening" retention have not, to the author's knowledge, been tested in a PubMed-indexed study.

The Rosen Screw is one of several direct-to-MUA screw families. The critical review groups them by head design: conical-seat screws that rely on frictional engagement at the head, flat-seat screws that use a planar seating surface and are intended to be more tolerant of small misfit, rounded or radiused heads meant to smooth stress transfer

in brittle monolithic zirconia, and alternative geometries with anti-rotational or concave head features[17]. The authors also note that most of these developments are driven by manufacturers and digital-workflow needs rather than comparative clinical evidence, that direct comparisons between designs are scarce, and that no single system can be considered universally superior[17]. A conical seat may also be more sensitive to seating accuracy and framework misalignment in complete-arch work, because several units must seat at once[17].

5.3 What the peer-reviewed evidence shows

The critical review concludes that preload loss, loosening and fatigue are the key mechanical concerns, that short-term clinical outcomes appear acceptable when biomechanical and prosthetic protocols are followed, and that long-term comparative data are lacking. It characterises titanium-base-free MUA restorations as a technique-sensitive approach requiring optimised screw selection, accurate prosthetic fit and controlled occlusal loading[17].

The closest laboratory comparison is a micro-CT study in which 40 implants were restored with Ti-base or multi-unit abutment crowns at straight or angulated positions, thermally aged, and loaded to failure. Mean failure loads were about 2,589 N (straight Ti-base), 1,768 N (angulated Ti-base), 3,318 N (straight MUA) and 2,213 N (angulated MUA). All systems withstood typical intraoral forces, but assemblies on angulated implants deformed at lower loads[19]. Note that this study compared Ti-base and multi-unit abutments rather than a Rosen Screw against a Ti-base, so it informs the concept but does not validate the product.

Table 1. Comparison of the bonded titanium-base workflow and the titanium-base-free (Rosen Screw-type) workflow.

Feature	Bonded Ti-base workflow	Titanium-base-free workflow (Rosen Screw-type)
Connection to MUA/implant	Prosthesis resin-bonded to a Ti-base, which is screwed down[3,4]	Prosthesis connected directly to the MUA by a conical-headed screw (manufacturer description)
Principal mechanical concern	Decementation at the bonded interface; retention depends on Ti-base height, surface treatment and cement[4,5,6]	Preload loss, loosening and fatigue of the single screw joint[17]
Bonding step	Required	Not required (manufacturer description)
Screw-head rationale	Conventional Ti-base screw	Conical/tapered head expected to resist loosening better than flat heads[15,16,17]
Failure load (straight / angulated), micro-CT study	Ti-base: ~2,589 N / ~1,768 N[19]	MUA: ~3,318 N / ~2,213 N (MUA-based assemblies, not the Rosen Screw itself)[19]
Effect of angulation	Lower failure load[19]	Lower failure load[19]; ~30° tolerance is a manufacturer claim
Evidence base	Reviews of 33 and 21 studies; long-term clinical data still limited[3,4]	Limited and fragmented; no long-term comparative data[17]

6. Screw-Retained Versus Cement-Retained Prostheses: Wider Clinical Context

The Ti-base versus titanium-base-free question sits inside a larger debate about how implant prostheses should be retained. Systematic reviews have compared survival and complication rates of screw- and cement-retained reconstructions[20,21]. A meta-analysis focused on marginal bone loss found less bone loss around cement-retained restorations over follow-up periods of 12 to 180 months, although the difference in means was small and may not be clinically significant[22]. The literature therefore does not support a simple ranking of the two retention types, and it offers no direct evidence on how a titanium-base-free screw connection compares with a bonded Ti-base within the screw-retained category.

7. Abutment Material Considerations

Independent of the Ti-base question, the choice of abutment material shapes the restorative outcome. Titanium is regarded as the gold-standard abutment material, with zirconia the most popular aesthetic alternative, and a systematic review and meta-analysis has compared their fracture resistance with and without ageing[23]. A systematic review of systematic reviews has compared the clinical outcomes of titanium and zirconia abutments more broadly[24], and fracture strength and failure mode have been compared across different

ceramic abutments in vitro[25]. These findings concern the abutment or superstructure material and apply to both bonded and titanium-base-free designs.

8. Clinical Considerations Drawn from the Literature

Several practical points recur across the studies reviewed. First, joint lubrication and accurate torque delivery influence the preload actually achieved[2]. Second, retightening a few minutes after the first tightening is supported by bench and review evidence[1,8,9]. Third, screw-head geometry matters, with conical and double-conical heads showing better loosening resistance than flat heads in bench testing[15,16]. Fourth, implant angulation reduces failure load and increases screw stress, so angulated positions deserve extra caution whichever abutment system is used[16,19]. Finally, because titanium-base-free restorations depend on a single screw joint, they call for accurate prosthetic fit, controlled occlusal loading and scheduled follow-up[17].

Table 2. Summary of key studies informing this review.

Study	Design	Main finding relevant to this review
Haack et al., 1995[7]	In vitro; elongation method on UCLA-type screws	Recommended torques produced ~57.5% (gold) and ~56% (titanium) of yield stress
Siamos et al., 2002[1]	In vitro; 25–40 N·cm with/without retorque, cyclic loading	Retighten ~10 min after first torque; torque above ~30 N·cm beneficial
Guda et al., 2008[2]	Probabilistic finite-element analysis	Target preload reached ~54% (lubricated) vs ~0.02% (dry)
Pardal-Peláez & Montero, 2017[8]	Systematic review of in vitro fatigue studies	Retightening is a positive factor for preload maintenance
Vinhas et al., 2022[9]	In vitro; four connection designs, cyclic loading	Loading lowered removal torque; multiple retightening gave higher values
Arnetzl et al., 2016[15]	In vitro; 80 assemblies, 3,000,000 cycles	Double-conical > conical > flat-head loosening torque
Sun et al., 2025[16]	In vitro + FEA; 30°–180° tapers, 15°–45° loading	Smaller-taper heads resisted loosening better; higher loading angles reduced loosening torque
Al-Thobity, 2022[3]	Literature review, 33 studies	High fracture strength and adequate retention; long-term clinical data needed
Moreno et al., 2023[4]	Literature review, 21 studies	Covers misfit, screw loosening, retention; taller Ti-bases improved zirconia crown retention
Duran Ilhan et al., 2025[19]	In vitro; 40 implants, micro-CT and SEM	Failure loads 2,589 / 1,768 / 3,318 / 2,213 N; angulation lowered failure load
Sananez et al., 2015[12]	In vitro; complete-arch mandibular prosthesis	Detorque influenced by dynamic loading and tightening sequence
Lemos et al., 2016[22]	Systematic review and meta-analysis	Less marginal bone loss with cement retention; small difference
Mosaddad et al., 2026[17]	Critical review	Titanium-base-free MUA evidence limited and fragmented; long-term data lacking

9. Gaps in the Evidence and Future Directions

Three gaps stand out. The first is product-specific data: no PubMed-indexed study identified for this review evaluates the Rosen Screw itself for preload retention, fatigue behaviour, angulation tolerance or clinical survival. The second is direct comparison: the existing micro-CT work compares Ti-base and MUA assemblies, not a titanium-base-free screw against a bonded Ti-base control with matched components[19]. The third is time: the available clinical evidence on titanium-base-free MUA restorations is short term[17]. Useful next studies would include angulation-stratified fatigue testing with preload and removal-torque measurement, using the methods already established in the screw-mechanics literature, and prospective clinical series with standardised recording of screw loosening, screw fracture and prosthetic complications.

10. Conclusion

The biomechanical case for conical, self-locking screw heads is supported by consistent bench evidence, and removing the bonded Ti-base eliminates one recognised failure mode of the Ti-base workflow. At the same time, removing the Ti-base places the full mechanical burden on one screw, angulation reduces failure load in every design tested, and the peer-reviewed evidence on titanium-base-free MUA connections is still limited and fragmented. For the Rosen Screw specifically, the claims made by the manufacturer are plausible but have not yet been independently tested in the indexed literature. Clinicians can reasonably use such systems with careful torque protocols, retightening, accurate fit and follow-up, while recognising that long-term, product-specific studies are still needed.

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