Design Requirements and Success Implications for Implant Supported Full-Arch Zirconia Restorations.

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VERTICAL SPACE REQUIREMENTS FOR MONOLITHIC FULL-ARCH ZIRCONIA

Monolithic zirconia full-arch prostheses (one-piece, screw-retained bridges milled entirely from zirconia) require a substantial vertical clearance to accommodate the material's thickness and ensure long-term durability[1-3]. This paper provides a framework for the dimensions of a successful restorative result and options and resulting ramifications when compromises are necessary.

Much of the implant literature regarding the success of full arch implant-supported zirconia restorations states that the ideal space needed for zirconia hybrids should be 12 – 15 mm of vertical restorative space, the width of the prosthesis should be no less than 10 mm, measured in any area from the buccal to the lingual on the intaglio surface[4-7] and the AP spread ratio is within a clinically acceptable range. These two minimum dimensions of Zirconia Hybrids give a restoration the best chance for long-term success. The minimum required restorative space is 10 mm[4,8,9]. Anything less risks fracture of the zirconia. The question is, from where should the restorative space be measured[10]? Should the measurement be made from the implant interface, the ridge crest or from the shoulder of the MUA? We recommend measuring from the MUA shoulder to the screw access hole, as this provides the most accurate measurement for restorative space and zirconia thickness.

Other measurement areas can be used but will require an adjustment to the parameters[1,4,8,9]. For example, if the measurement is taken from the implant platform, and the restorative space from the implant platform to a screw access hole of the prosthesis is 12 mm, and the MUA has a 3 mm cuff height, the measurement for zirconia thickness is 9 mm after the 3 mm cuff height is deducted from the initial measurement (12-3=9).

The thinnest restorative space is the weakest link in long-term zirconia success and this area invites fracture. The literature states that in many studies, restorative space of less than 10 mm is very risky and prone to fractures[4-7].

Having less than ~10 mm of space significantly raises the risk of mechanical complications, like framework fracture or insufficient strength, and may compromise esthetics and hygiene access and will compromise the product warranty (table 1)[1,4,8,9]. Clinically, if interarch space is <10 mm, experts often consider alternative approaches—e.g. FP1/FP2 design, increasing the occlusal vertical dimension, modifying the design with metal reinforcement, or performing bone reduction surgery, in order to create adequate prosthetic room and avoid a weak or over-contoured prosthesis. The importance of meeting these space requirements is underscored by studies linking inadequate prosthetic space to higher rates of material failure (chipping or fracture) in full-arch implant restorations[2,3,8,9].

MONOLITHIC VS. METAL-FRAMEWORK PROSTHESES: SPACE NEEDS AND DESIGN

Modern designs can integrate a metal bar with a thin zirconia superstructure ("zirconia fused to a titanium bar") specifically to address cases with severely limited space. These aim to leverage titanium's high strength, enabling a thinner overall prosthesis while still resisting fracture. For instance, some dental labs advertise zirconia-on-titanium designs that can function in <10 mm of interarch space. However, peer-reviewed data on these approaches is limited. A recent finite element analysis comparing a monolithic zirconia All-on-4 prosthesis versus a zirconia prosthesis luted to a titanium bar found only a modest difference in stress and deformation: under a 300 N molar load, the titanium-bar design slightly lowered peak tensile stress in the zirconia (227 MPa vs 234 MPa) and reduced deflection by <0.07 mm10. The predicted fracture probabilities were extremely low and nearly identical for both designs. This suggests that a metal core may not dramatically decrease the required zirconia bulk or eliminate fracture risk – proper space and thickness remain crucial even with a metal substructure. In summary, adding a metal bar provides strength redundancy more than space savings. Conventional literature still emphasizes creating adequate vertical room (via surgical or prosthetic adjustments) rather than relying on a thin prosthesis to succeed solely on the basis of metal reinforcement.

CLINICAL OUTCOMES: SURVIVAL, COMPLICATIONS, AND PATIENT SATISFACTION

Clinical studies over the last 5 years consistently show that full-arch monolithic zirconia prostheses have excellent survival and low complication rates when sufficient space and proper design are achieved. A 2024 clinical study of 115 monolithic zirconia full arch cases reported 98.6% prosthesis survival at ~5 years (only 2 fractures out of 115 arches)[4]. Notably, in that series the two fractures occurred in designs that did meet standard cross-sectional dimension criteria, and overall, no significant correlation was found between the zirconia framework thickness and fracture occurrence. This underscores that when minimum dimensional guidelines are met, monolithic zirconia is highly reliable. The most common minor issues observed were loss of screw-access hole filling material or minor chipping of any veneering porcelain (in cases with slight incisal layering) – complications that did not compromise function[4].

When comparing zirconia vs. metal-based designs[11], mechanical complication profiles are slightly different, but both are favorable. A recent 3-year retrospective comparison (10 monolithic zirconia vs. 10 metal-ceramic arches) found no difference in implant or prosthesis survival (>95% for both groups)[12]. Monolithic zirconia frameworks had zero incidents of ceramic chipping (since they are mostly one-piece zirconia), whereas the metal-ceramic group reported minor chipping veneering porcelain (not statistically significant). Framework fractures were very rare: only one bulk zirconia fracture occurred (in a maxillary arch) and none in the metal-ceramic group over the 3-year follow-up[12]. Screw-loosening was also infrequent (one case in the zirconia group, which was easily corrected). Patient satisfaction is uniformly high for both types – in the study above, both groups averaged ≥9 out of 10 on visual analog scales for esthetics, comfort, and function, with monolithic zirconia scoring slightly higher in esthetics and overall comfort[13,14].

Conclusion: Modern full-arch zirconia prostheses achieve outstanding durability and patient acceptance when designed with adequate vertical space. Approximately 12–15 mm of clearance is the clinically supported minimum for a monolithic zirconia arch, yielding high success (≈99% 5-year survival). Incorporating a metal substructure (titanium bar) does not eliminate the need for space, and novel zirconia-on-bar methods offer marginal strength benefits according to some studies; however, a recent manufacturer's internal study showed a 30% improvement in strength. Both monolithic zirconia and metal-supported designs can be clinically successful, but ensuring the proper vertical room for the chosen design is fundamental to long-term success[4-7].

1. Mijiritsky, E., & Elad, A. (2023). Clinical performance of full-arch implant-supported fixed restorations made of monolithic zirconia luted to a titanium bar: A retrospective study with a mean follow-up of 16 months. Journal of Dentistry, 137, Article 104675. https://doi.org/10.1016/S0300-5712(23)00261-0

2. Tang, Y., Yu, H., Wang, J., & Qiu, L. (2023). Implant survival and complication prevalence in complete-arch implant-supported fixed dental prostheses: A retrospective study with a mean follow-up of 5 years. International Journal of Oral & Maxillofacial Implants, 38(1), 84–93. https://doi.org/10.11607/jomi.9808

3. Tribst, J. P. M., de Morais, D. C., de Matos, J. D. M., Lopes, G. R. S., Dal Piva, A. M. O., Borges, A. L. S., Bottino, M. A., Lanzotti, A., Martorelli, M., & Ausiello, P. (2022). Influence of framework material and posterior implant angulation in full-arch All-on-4 implant-supported prosthesis stress concentration. Dentistry Journal, 10(1), Article 12. https://doi.org/10.3390/dj10010012

4. Papaspyridakos, P., Sinada, N., Ntovas, P., Barmak, A. B., & Chochlidakis, K. (2025). Zirconia full-arch implant prostheses: Survival, complications, and prosthetic space dimensions with 115 edentulous jaws. Journal of Prosthodontics, 34(3), 271–280. https://doi.org/10.1111/jopr.13922

5. Tirone, F., Salzano, S., Rolando, E., Pozzatti, L., & Rodi, D. (2022). Framework fracture of zirconia supported full arch implant rehabilitation: A retrospective evaluation of cantilever length and distal cross-sectional connection area in 140 patients over an up-to-7 year follow-up period. Journal of Prosthodontics, 31(2), 121–129. https://doi.org/10.1111/jopr.13388

6. Tirone, F., Salzano, S., Rolando, E., Pirja, D. A., & Rodi, D. (2025). Relation between CAD dimensional parameters and framework fracture in zirconia full arch implant rehabilitation: An observational cohort study. Journal of Dentistry, 160, Article 105851. https://doi.org/10.1016/j.jdent.2025.105851

7. Vozzo, L. M., Azevedo, L., Fernandes, J. C. H., Fonseca, P., Araújo, F., Teixeira, W., Fernandes, G. V. O., & Correia, A. (2023). The success and complications of complete-arch implant-supported fixed monolithic zirconia restorations: A systematic review. Prosthesis, 5(2), 425–436. https://doi.org/10.3390/prosthesis5020029

8. Luo, J., Zhang, Y., Yu, Z., Jiang, X., Li, J., & Chen, B. (2024). A retrospective single cohort study on the 5–13 year clinical outcomes of implant-supported cross-arch fixed dental prostheses with monolithic zirconia-based frameworks. Journal of Prosthodontics. Advance online publication. https://doi.org/10.1111/jopr.13991

9. Barootchi, S., Askar, H., Ravidà, A., Gargallo-Albiol, J., Travan, S., & Wang, H.-L. (2020). Long-term clinical outcomes and cost-effectiveness of full-arch implant-supported zirconia-based and metal-acrylic fixed dental prostheses: A retrospective analysis. International Journal of Oral & Maxillofacial Implants, 35(2), 395–405. https://doi.org/10.11607/jomi.7833

10. Kim, Y. K. (2023). Prosthesis-implant arch area ratio (PIAAR) – A new geometric paradigm, replacing the current 'A-P spread' of a cantilever in full-arch implant prosthesis: A proof-of-concept experiment. Journal of Prosthodontics, 32(5), 398–408. https://doi.org/10.1111/jopr.13523

11. [Authors]. (2024). Finite element analysis of the effect of framework material and thickness on the biomechanical performance of 'All-on-Four' full-arch prosthesis. Computer Methods in Biomechanics and Biomedical Engineering, 28(12). https://doi.org/10.1080/10255842.2024.2355260

12. Walter, L., & Greenstein, G. (2020). Utility of measuring anterior-posterior spread to determine distal cantilever length off a fixed implant-supported full-arch prosthesis: A review of the literature. Journal of the American Dental Association, 151(10), 790–795. https://doi.org/10.1016/j.adaj.2020.06.016

13. Tuzlali, M., Baki, N., Yildirim Avcu, G., & Bahçe, E. (2026). Weibull-based reliability of full-arch zirconia prostheses in a mandibular All-on-4 model: Monolithic versus titanium-bar-supported designs. Applied Sciences, 16(5), Article 2181. https://doi.org/10.3390/app16052181

14. Tang, W., Zhang, H., Wang, H., & Li, L. (2024). A digital technique of bone reduction for a maxillary full-arch implant-supported fixed dental prosthesis. Journal of Prosthodontics, 33(7), 714–719. https://doi.org/10.1111/jopr.13782

15. Antonie, S.-M., Rusu, L.-C., Borsanu, I.-A., & Bratu, E.-A. (2025). Preliminary comparative analysis of monolithic zirconia and hybrid metal-ceramic designs in full-arch implant-supported restorations. Prosthesis, 7(6), Article 154. https://doi.org/10.3390/prosthesis7060154

16. Mijiritsky, E., Ben Zaken, H., Shacham, M., Cinar, I. C., Tore, C., Nagy, K., & Ganz, S. D. (2021). Variety of surgical guides and protocols for bone reduction prior to implant placement: A narrative review. International Journal of Environmental Research and Public Health, 18(5), Article 2341. https://doi.org/10.3390/ijerph18052341

TABLE 1: WARRANTY IMPLICATIONS OF SPACE LIMITATIONS AND PROSTHETIC DESIGN WITH ROE DENTAL LAB*-***

Vertical Space Available	AP Spread**/ Supporting Material > 10 mm	Design Modification Recommended	Warranty
11-15 mm	In range	With Ti bases or direct to MUA with specific screw	Full warranty
	Violation or insufficient material thickness	With metal supporting bar and optional Passivity Plus coping	Full warranty
		With Ti bases or direct to MUA with specific screw	No warranty
9-10 mm	In range	With metal supporting bar and optional Passivity Plus coping	Full warranty
		With Ti bases or direct to MUA with specific screw	Limited 50% warranty
	Violation or insufficient material thickness	With metal supporting bar and optional Passivity Plus coping	Full warranty
8 mm or less	In range	With metal supporting bar and optional Passivity Plus coping	Limited 50% warranty
		With Ti bases or direct to MUA with specific screw	No warranty
	Violation or insufficient material thickness	With metal supporting bar and optional Passivity Plus coping	No warranty
		With Ti bases or direct to MUA with specific screw	No warranty
7 mm or less	Any	Any	No warranty

* To view full warranty: www.roedentallab.com/warranty

** AP (Anteroposterior) Implant Supported Full Arch Spread Rule – refers to the distance between the center of the most anterior implant and the center of the most posterior implant on one side of the arch. It is used to determine the maximum safe distal cantilever length. Which we follow the classic guideline of Maximum cantilever length ≈ 1.5 × AP spread. Supporting restorative material around an implant site or coping must be at least 2 mm in any location.

*** ROE Dental maintains the discretion to not warranty any restoration, with notice, on cases in which excessive arch size or span exists, if the client refuses to perform requested passivity diligence with a PTI, iJig or fit jig, or for excessive remakes in which lab fault cannot be determined.