# The Significance Of Passive Framework Fit In Implant Prosthodontics: Current Status

Saime Sahin, DDS, PhD,* Murat C. Çehreli, DDS, PhD**

*The clinical and laboratory procedures employed for framework fabrication are inadequate to provide an absolute passive fit for implant-supported fixed superstructures. Although some prosthetic complications are attributed to the lack of passive fit, its effect on implant success is questionable. Nevertheless, the clinical results of increasing applications of advanced technology to improve framework fit seem promising. This article reviews the clinical significance of passive fit and the factors that affect the final fit of implant-supported frameworks. (Implant Dent 2001;10:85–92)*

***Key Words: screw-retained prosthesis, cement-retained prosthesis, superstructure misfit, passive fit***

The introduction of osseointegration has dramatically affected the discipline and current perspective of implantology and improved the quality of life of many completely edentulous patients.[1–3] Concurrent with the concept, the use of dental implants has successfully expanded for applications in partial edentulism, maxillofacial prosthetics, and orthodontic anchorage.[4–10] Recently, early loading of osseointegrated implants has been reported.[11] Furthermore, if the clinical objective is to provide a prosthesis at the day of implant surgery, probably the most spectacular improvement has been introduced by the Brånemark Novum System (Nobel Biocare, Göteborg, Sweden) to deliver an implant-supported fixed mandibular prosthesis to a completely edentulous jaw in approximately seven hours.[12] Thus it is an undisputed fact that osseointegrated implants are dependable and efficient and have demonstrated an improved success rate over years.

The increased number of clinical applications has led to many scientific investigations that have contributed to an evolution in implant systems, treatment concepts, and techniques used for framework fabrication. During the last three decades, the significance of the biomechanical aspect of implant treatment has been emphasized and safety measures[13–20] have been suggested and applied to control the biomechanical load over dental implants.

A rigid connection between osseointegrated implants and a fixed superstructure induces strains in each component exposed to force. The superimposition of functional loads generates additional strains that affect the entire bone-implant-prosthesis assembly. One of the major challenges to a prosthodontist is the delivery of an acceptable prosthesis that will not compromise the longevity of the resultant treatment.

## THE SIGNIFICANCE OF PASSIVE FIT

Implant-supported fixed prostheses comprise essentially screw-retained and cement-retained superstructures.[21,22] The use of any retention technique necessitates a profound evaluation of a number of significant premises and parameters. Among these, the clinical aspect of passive fit has not been demonstrated, and claims regarding the subject are largely anecdotal. Although the challenge to apply advanced technology for the improvement of framework fit is ongoing, the phenomenon still remains an elusive goal that is to be attained by the discerning implant prosthodontist.[23]

Passive fit (synonymous with "ideal fit") is assumed to be one of the most significant prerequisites for the maintenance of the bone-implant interface. To provide passive fit or a strain-free superstructure, a framework should, theoretically, induce absolute zero strain on the supporting implant components and the surrounding bone in the absence of an applied external load. This vital requirement may be provided by simultaneous and even mating of the complete inner surfaces of all retainers by all abutments. However, according to the current scientific evidence and with the efficacy of contemporary dental technology used for framework fabrication, it has been concluded that an absolute passive fit cannot be obtained.[24] Prosthetic complications such as gold (fixation) screw loosening or fracture, abutment screw fracture, gold

---

*Professor, Department of Prosthodontics, Faculty of Dentistry, Hacettepe University, Ankara, Turkey.
**Research Assistant, Department of Prosthodontics, Faculty of Dentistry, Hacettepe University, Ankara, Turkey.

ISSN 1056-6163/01/01002-085$3.00
Implant Dentistry
Volume 10 • Number 2

cylinder, frameworks, and veneers have been documented and may be related to poor framework fit.[23,25] However, there is no longitudinal clinical study that reports implant failure specifically attributed to framework misfit. The vital question then arises as to whether absolute passive framework connection is really essential and if it is a governing factor for implant success. In an excellent review by Taylor et al[22], one of the major problems was stated as follows: "If it is assumed that misfit is a real problem when dealing with dental implants, 2 questions must be asked. First, what level of misfit is clinically important, beyond which damage is likely to occur? The answer to this question is obviously very complex and probably depends upon such factors as bone quality, length and diameter of implants, and implant surface characteristics. Secondly, assuming that misfit is a concern, how does one measure it in a clinical situation?"

Location, direction, and magnitude of applied loads,[26–29] the type and design of the superstructure,[30] and the correct interpretation of the qualitative nature and the quantification of stresses around load-carrying implants is often a challenge because of the inevitable inclusion of several governing factors such as bone density,[31] diameter, length, width, number, location, and macrodesign of dental implants.[32] The problem is probably more perplexing than it seems. For instance, the correct determination of the physiologic tolerance level of an ill-fitting superstructure would require the *in vivo* investigation of the isolated strains in bone, implants, and the prosthesis by empirically testing several superstructures with various degrees of misfit. Accordingly, in a study conducted by Carr and co-workers,[33] screw-retained misfitting superstructures were connected to implants in baboons where it was not possible to distinguish a difference in bone response in two levels of misfit and in the absence of applied occlusal load. One of the reasons for failure was attributed to the possibility that the implant abutment could have absorbed some of the misfit-induced strain and decreased the strain transferred to the implant-bone interface. Assuming that this is true, the isolation of absorbed strains on each component must be provided to ensure the correct interpretation of strains throughout the load-bearing system. This is not currently available.

An acceptable marginal fit of a restoration is not a sign of passive fit. Although there is a consensus that framework misfit causes adverse biologic host response, the clinically acceptable amount of superstructure passivity has not been determined for implant-supported restorations. The only method for determining the actual amount of superstructure passivity *in vivo* is the analysis of the strains on each implant abutment and/or component of the prosthesis before and/or after cementation or screw-fixation. Following such a procedure is certainly time consuming and would require the bonding of a number of strain gauges that also requires the use of sophisticated and expensive equipment. This is definitely not practical, and its inclusion in a routine treatment protocol does not seem rational.

Contemporary prosthodontic treatment for implant-supported prostheses is comprised mostly of derivations and empirical modifications of traditional clinical and laboratory procedures. After following appropriate adjustment procedures, the cement-retained prostheses are accepted to be passive when placed on implant abutments. Although not substantiated by research, this assumption has been introduced as an advantage over screw-retained superstructures and has probably led to the placement of an infinite number of nonpassive prostheses. Clelland and Van Putten[34] have demonstrated that when compared with conventional screw fixation for mandibular fixed prostheses resin luting actually decreases the strains in a bone simulant surrounding the collar of implants. However, during framework fabrication, although plastic shims were used to compensate for the dimensional discrepancies, passive fit was not established. For a screw-retained prosthesis, if the marginal gaps between the framework and abutments are excessive, large external preloads are introduced on the implant abutments and fixation screws, causing loosening or fracture.[35–41] The loosening of the fixation or gold screw is attributed to the insufficient counteracting torque (tension in the stem of the screw) to the bending of an ill-fitting framework when connected to implant abutments. Consequently, a lever arm is created that inevitably causes overloading of all components of the neighboring implant. If not, the built-in stress may cause fracture of the framework unless it is fabricated with adequate bulk. In this situation, stresses are transferred to the abutment and the implant. These may trigger complications regarding the abutment screw and may compromise the integrity of the implant-bone interface.[39,40]

Considering that the distance between screw threads of the gold screw in the Brånemark System (Nobel Biocare) is 300 $\mu$m, the effect of marginal discrepancy is worse when the clinical marginal gap is about 150 $\mu$m.[42] This situation places a risk on the longevity of the gold screw. The same misfit level also seems to be applicable for most clinical applications. Because the marginal gap of multi-unit castings often approaches several microns,[43] a cast implant-supported multi-unit one-piece fixed prosthesis will surely have wide gaps between the abutment and the prosthesis. Screw tightening causes strains in and around dental implants, and its magnitude is dependent on the amount of misfit.[38,44] The screw tension introduced in the gold screw joint for the Brånemark System (Nobel Biocare) is measured as approximately 300 N.[38,45] Distortion of both the superstructure and the implant is observed during the tightening of a screw-retained superstructure.[46] In such cases, the amount of distortion may reach a level such that a 500 $\mu$m marginal gap may not be detectable with an explorer.[44] A subtle closure of gaps occurs. Prestresses in the entire system may cause complications associated with cyclic fatigue under continual application of functional loads over time. However, the amount of misfit of a conventional cast superstructure does not induce marginal bone loss over years; a hypothesis that has been put forth regarding a compensating biologic tolerance mechanism.[47] In a retrospective study, Kallus and Bessing[41] have claimed that 236 patients wearing actually misfitting implant-supported prosthesis for at least five years had no signs of loss of osseointegration and that misfit of the superstructures did not affect the maintenance of marginal bone level. It seems that the biologic response for misfit levels between 38 μm and 345 μm is similar.[33] Accordingly, the implant success rate for screw-retained prostheses is high, and, as stated previously, implant failures specifically attributed to nonpassive superstructures have not been documented. Clinical procedures that are followed for framework fit evaluation are empirical, and evaluations are based on direct visualization and tactile sense, leading to uncalibrated (uncontrolled) human evaluation that is undependable.[37]

The fit of a cast framework is supposed to be evaluated in both the laboratory and the patient's mouth. According to the one-screw test, it is recommended to screw the framework from the most distal abutment and check for possible lifting of the frame. Then, the middle gold screw is placed, and so forth. After placing the gold screws one by one, a final 180 degree turn is performed to reach a torque of 10 Ncm for complete screw seating. If more than a half turn is needed to provide seating of the gold screw, the framework is a misfit and requires further clinical and laboratory work. There are alternative methods for the clinician to check the seating of frameworks. Detection of any marginal gap may be accomplished by using an explorer, a fit-checker, enhanced lighting, or magnification. The detection of a gap is an indication that sectioning and soldering (or welding) are required.[48–50] Additionally, framework-fit evaluation in the patient includes the subjective determination of tension or pain that also lead to sectioning. Soldering or laser-welding of sectioned prosthetic components does not necessarily provide a passive fit. They do provide an overall decrease in the strains around implants, which may result in an overall decrease in gold screw loosening frequency.[51–53]

### The Measurement of Distortion

The use of a computer numeric controlled milling technique[54] and premachined titanium components for laser-welded framework fabrication[55] facilitates improved marginal fit and seems clinically predictable in comparison with cast frameworks. However, Jemt and co-workers[54] also reported that there was a three-dimensional distortion of the gold cylinders ranging between 3 μm and 80 μm and that there was no significant difference between the fit of cast- and computer numeric controlled-milled frameworks and the lack of passive fit. The marginal discrepancy of frameworks fabricated by the All-In-One technique (Nobel Biocare) is around 30 μm (personal verbal communication; Hans Nilson, 1999, Umeå, Sweden). According to Van Roekel,[56] precise passive fit is established if electrical discharge machining is used for framework fabrication. However, the study did not include the method of evaluation of fit.

Measurement of the exact three-dimensional distortion of a framework (the marginal discrepancy) is a difficult task. Achievement of accurate and verifiable measurements can only be provided by following a dependable protocol and using a precise measuring device. Systems used to quantify the three-dimensional framework distortion are the Mylab, University of Washington, three-dimensional photogrammetry, and University of Michigan systems.[42,47,57–62] Additionally, Jemt and collegues[53,54] have also demonstrated that the photogrammetry technique is valid as an alternative to conventional impressions while following the computer numeric controlled milling technique for framework fabrication and that it could also be used to measure the mucosal topography around dental implants. Among current measurement methods, photogrammetry is the only method that can record data intraorally. Use of the Mylab coordinate measuring machine seems to provide the most accurate results *in vitro*.[57]

Regardless of which fabrication technique or alloy is used, the distortion of a framework occurs on three planes (*x*, *y*, and *z*). The distortion is pronounced in the horizontal plane (*x* and *y*), and it is directly proportional to the increase in width or curvature of the arch. More distortion occurs when using conventional cast or laser-welding of titanium components horizontally instead of vertical welding.[34,46,47,51,52] Jemt and Lie[42] demonstrated that the rate of angular distortion for individual cylinders measured by the photogrammetry method in a cast mandibular full-arch one-piece framework ranged between 11 μm and 181 μm. The distortion in the sagittal direction (*y* axis) was pronounced. Accordingly, the cylinders exhibited an approximate posterior angulation of 16 μm. The angular distortion values recorded for the maxilla ranged between 133 μm and 315 μm. A trend for sagittal distortion was also observed.

### Effect of Treatment Time on Framework Fit

For tooth-supported multi-unit fixed prostheses, the evaluation of the passivity of a cast restoration is not required. Because of the curvature of the arch and movement of the teeth in the anterior and posterior segments, variable magnitudes and directions may create stresses in long-span prostheses. Research in periodontometry has revealed that natural teeth exhibit buccolingual movement between 56 μm and 108 μm and an intrusion of 28 μm under applied load, which is particularly related to the existence of the periodontal ligament.[63] Because osseointegrated implants are completely surrounded by bone and the interface is nonresilient, minimal movement is observed that is attributed to the deformation of the bone under load. Dental implants and natural teeth follow different patterns to applied loads. The periodontal ligament has a cushioning effect, and natural teeth have the inherent tendency to migrate when overloaded. Implants, on the other hand, distribute the applied load throughout the system and transfer it to the bone. This explains the cause of the intrusion of natural teeth in a tooth-implant-supported fixed prosthesis.[64,65] When a fixed prosthesis is connected to osseointegrated implants, lateral forces are applied that may trigger cortical bone resorption or appear as prosthetic complications after superimposition of functional stresses. This scenario may change according to the treatment protocol followed. Although achievement of a 100% osseointegrated implant does not seem possible, there is a consensus that 70% bone-implant contact is capable of bearing *in vivo* functional loads.[66] The progenitor philosophy for the doctrine of osseointegration was based on a two-stage surgical protocol, and it was extremely important to avoid loading the submerged implants during the healing period. Brånemark[67] envisaged a healing phase of 0 to 12 months to the stable, resting implant, a remodeling phase of 3 to 18 months after introduction of functional loads, and a steady state after 18 months wherein an equilibrium was established between the forces acting upon the implant and the remodeling capacities of the anchoring bone. However, the success of so-called immediate or early loading and consecutive research[68–70] have actually revealed that implants may be loaded in a relatively short period of time after installation only in the anterior mandible that is to support a fixed prosthesis. This treatment option emphasizes the fact that the anterior mandible, which is often composed of highly dense bone, has the inherent potential to provide adequate support and initial stability for dental implants that are supposed to bear functional loads early (about one week) after implant placement. It is believed that early-loaded implants are initially stable and do osseointegrate in time (personal communication; Ingvar Ericsson, 1999). The clinical application of the Brånemark Novum System (Nobel Biocare) is comprised of the placement of the majority of the implants (123 of 150) in bone quality 2[71] provided immediate loading of dental implants. Thus, after three decades of research and experience, the philosophy has evolved into a same-day treatment protocol.[12] The system may have provided a significant advance in superstructure fit by having the potential of being almost passive in time to provide a compensating micromovement of the implant through applied load by the minimally misfitting superstructure, which may easily be accomplished in seven hours. From a prosthetic aspect, the elimination of an impression and all subsequent steps that are followed for cast superstructures is of utmost importance because the materials and methods used for these procedures affect the final fit of a framework. All components, including the framework, are prefabricated, and implants are installed in accordance with the framework that is provided by the use of a series of accurate surgical guides. Machining tolerance between components is inevitable and may be compensated by features incorporated into the design. The performance of an implant system is directly related to implant design. The implants used in the Novum System are different from the traditional two-stage Brånemark System. If they are not, then the decrease in the number of supporting implants would cause a detrimental increase in induced stresses around the implants, particularly when cantilever loading.[15,66]

### Outcomes of Current Clinical and Laboratory Techniques

Each step of the fabrication of a cast framework influences the final fit. A minimal discrepancy (22–100 $\mu$m) exists between impression copings and either the prosthetic abutment or the abutment replica. This should be considered when making the final impression and during master cast production.[72] The impression material[73,74] and the technique followed[75,76] affect the final fit of the framework. Dimensional changes related to the use of square impression copings are relatively lower than tapered copings, and it is generally recommended to unite them with a dimensionally stable pattern resin.[36] The setting expansion of dental stone influences the final fit of frameworks, but it cannot be changed.[77] Thus, various fabrication techniques have been employed for master cast fabrication. Vigolo and Millstein[77] have observed that the use of sectioned master casts provides superior fit in comparison to the use of solid casts. There is also a minimal machining tolerance between gold cylinders and abutment replicas that cannot be avoided.[72]

While fabricating a pattern, two basic aspects should be evaluated. First, the final distortion will definitely be more if wax is used[37] instead of a resin, which has low polymerization shrinkage.[36] Second, the design and bulk should provide adequate strength for the framework. However, an increase in the volume of the pattern causes more casting shrinkage, indicating a restriction of the bulk of the pattern.[37,78] The investment material setting expansion, investment technique, and the type of casted alloy also affect the magnitude of any final discrepancy.[37,78,79] Although gold alloys have lower casting shrinkage than cobalt-chromium alloys, three-year clinical results of cobalt-chromium frameworks are promising.[78] One-piece complete-arch frameworks generally require sectioning and soldering (or welding) to improve fit. The determination of the connector that is to be sectioned is completely dependent on the clinical experience of the practitioner; however, steps should be followed for the soldering process that affects the final fit.[23,37] There is an overall decrease in bone strains around dental implants when superstructures are soldered or laser welded.[44,51–53]

## CONCLUSION

Absolute passive framework fit has not been achieved in the last three decades. There is no consensus but rather a number of suggestions regarding the acceptable level of misfit. In light of current knowledge, although there are claims that passive fit is a governing factor over the maintenance of osseointegration and implant success, there is a rising opposing trend in relevant literature. The materials and the techniques used for fabricating cast-frameworks are not dimensionally accurate and require further research and development. Obtaining a passive fit does not seem to be possible and may in fact be unnecessary.

## REFERENCES

1. Brånemark P-I, Hansson BO, Adell R, et al. Osseointegrated implants in the treatment of the edentulous jaw: Experience from a ten year period. *Scand J Plastic Reconsrt Surg.* 1977;Suppl:1–132.
2. Adell R, Lekholm U, Rockler B, et al. A 15-year study of osseointegrated implants in the treatment of edentulous jaw. *Int J Oral Surg.* 1981;10:387–416.
3. Adell R, Erikkson B, Lekholm U, et al. A long-term follow up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants.* 1990;5:347–359.
4. Lekholm U, Van Steenberghe D, Hermann I, et al. Osseointegrated implants in the treatment of partially edentulous jaws: A prospective 5-year multicenter study. *Int J Oral Maxillofac Implants.* 1994;9:627–635.
5. Van Steenberghe D, Lekholm U, Bolender C, et al. The applicability of osseointegrated oral implants in the rehabilitation of partially edentulism: A prospective multicenter study on 558 fixtures. *Int J Oral Maxillofac Implants.* 1990;5:272–281.
6. Jemt T, Lekholm U. Oral implant treatment in posterior partially edentulous jaws: A 5-year follow-up report. *Int J Oral Maxillofac Implants.* 1993;8:635–640.
7. Goodacre CJ, Brown DT, Roberts WE, et al. Prosthodontic considerations when using implants for orthodontic anchorage. *J Prosthet Dent.* 1997;77:162–170.
8. Higuchi KW, Slack JM. The use of titanium fixtures for intraoral anchorage to facilitate orthodontic tooth movement. *Int J Oral Maxillofac Implants.* 1991;6:338–344.
9. Ismail JY, Zaki HS. Osseointegration in maxillofacial prosthetics. *Dent Clin North Am.* 1990;34:327–41.
10. Akça K, Iplikçiolu K, Akça E. A multidisciplinary approach to single-tooth, implant-supported prostheses: A report of three cases. *J Oral Implantol.* 2000;26:199–203.
11. Randow K, Ericsson I, Nilner K, et al. Immediate functional loading of Brånemark dental implants. An 18-month clinical follow-up study. *Clin Oral Implants Res.* 1999;10:8–15.
12. Brånemark P-I, Engstrand P, Ohrnell L-O, et al. Brånemark Novum: A new treatment concept for rehabilitation of the edentulous mandible. Preliminary results from a prospective clinical follow-up study. *Clin Implant Dent Rel Res.* 1999;1:2–16.
13. Skalak R. Biomechanical considerations in osseointegrated prostheses. *J Prosthet Dent.* 1983;49:843–848.
14. Rangert B, Jemt T, Jörneus L. Forces and moments on Brånemark implants. *Int J Oral Maxillofac Implants.* 1989;4:241–247.
15. Osier JF. Biomechanical load analysis of cantilevered implant systems. *J Oral Implantol.* 1991;17:40–47.
16. Kregzde M. A method of selecting the best implant prosthesis design option using three-dimensional finite element analysis. *Int J Oral Maxillofac Implants.* 1993;8:662–673.
17. Weinberg LA, Kruger B. A comparison of implant/prosthesis loading with four clinical variables. *Int J Prosthodont.* 1995;8:421–433.
18. Dallenbach K, Hurley E, Brunski JB, et al. Biomechanics of in-line vs. offset supporting a partial prosthesis [abstract]. *J Dent Res* 1996;75:183.
19. Weinberg LA, Kruger B. An evaluation of torque (moment) on Implant/Prosthesis with staggered buccal and lingual offset. *Int J Periodontics Restorative Dent.* 1996;16:253–265.
20. Weinberg LA. Reduction of implant loading using a modified centric occlusal anatomy. *Int J Prosthodont.* 1998;11:55–69.
21. Hebel KS, Gajjar RS. Cement-retained versus screw-retained implant restorations: Achieving optimal occlusion and esthetics in implant dentistry. *J Prosthet Dent.* 1997;77:28–35.
22. Taylor TD, Agar JR, Vogiatzi T. Implant prosthodontics: Current perspective and future directions. *Int J Oral Maxillofac Implants.* 2000;15:66–75.
23. Tan KBC. The clinical significance of distortion in implant prosthodontics: Is there such a thing as passive fit? *Ann Acad Med Singapore.* 1995;24:138–157.
24. Carlsson L. Built-in strain and untoward forces are the inevitable companions of prosthetic misfit. *Nobelpharma News.* 1994;8:5.
25. Sones AD. Complications with osseointegrated implants. *J Prosthet Dent.* 1989;62:581–585.
26. Stegaroiu R, Sato T, Kusakari H, et al. Influence of restoration type on stress distribution in bone around implants: A three-dimensional finite element analysis. *Int J Oral Maxillofac Implants.* 1998;13:82–90.
27. Assif D, Marshak B, Horowitz A. Analysis of load transfer and stress distribution by an implant-supported fixed partial denture. *J Prosthet Dent.* 1996;75:285–291.
28. Hobkirk JA, Havthoulas TK. The influence of mandibular deformation, implant numbers, and loading position on detected forces in abutments supporting fixed implant superstructures. *J Prosthet Dent.* 1998;80:169–174.
29. Barbier L, Sloten JV, Krzensinki G, et al. Finite element analysis of non-axial versus axial loading of oral implants in the mandible of the dog. *J Oral Rehabil.* 1998;25:847–858.
30. Jemt T, Carlsson L, Boss A, et al. In vivo load measurements on osseointegrated implants supporting fixed or removable prostheses: A comparative pilot study. *Int J Oral Maxillofac Implants.* 1991;6:413–417.
31. Holmes DC, Loftus JT. Influence of bone quality on stress distribution for endosseous implants. *J Oral Implantol.* 1997;23:104–111.
32. Holmgren EP, Seckinger RJ, Kilgren LM, et al. Evaluating parameters of osseointegrated dental implants using finite element analysis—A two dimensional comparative study examining the effects of implant diameter, implant shape and load direction. *J Oral Implantol.* 1998;24:80–88.
33. Carr AB, Gerard DA, Larsen PE. The response of bone in primates around unloaded dental implants supporting prostheses with different levels of fit. *J Prosthet Dent.* 1996;76:500–509.
34. Clelland NL, Van Putten MC. Comparison of strains produced in a bone stimulant between conventional cast and resin-luted implant frameworks. *Int J Oral Maxillofac Implants.* 1997;12:793–799.
35. Carr AB, Brunski JB, Hurley E. Effects of fabrication, finishing and polishing procedures on preload in prostheses using conventional gold and plastic cylinders. *Int J Oral Maxillofac Implants.* 1996;11:589–598.
36. Ness EM, Nicholls JI, Rubenstein JE, et al. Accuracy of the acrylic resin pattern for the implant-retained prosthesis. *Int J Prosthodont.* 1992;5:542–549.
37. Tan KB, Rubenstein JE, Nicholls JI, et al. Three-dimensional analysis of the casting accuracy of one-piece, osseointegrated implant-retained prosthesis. *Int J Prosthodont.* 1993;6:346–363.
38. Smedberg JI, Nilner K, Rangert B, et al. On the influence of superstructure connection on implant preload: A methodological and clinical study. *Clin Oral Implants Res.* 1996;7:55–63.
39. Kohavi D. Complications in the tissue integrated prostheses components: Clinical and mechanical evaluation. *J Oral Rehabil.* 1993;20:413–422.
40. Balshi TJ. An analysis and management of fractured implants: A clinical

report. *Int J Oral Maxillofac Implants.* 1996;11:660–666.

41. Kallus T, Bessing C. Loose gold screws frequently occur in full-arch prostheses supported by osseointegrated implants after 5 years. *Int J Oral Maxillofac Implants.* 1994;9:169–178.

42. Jemt T, Lie A. Accuracy of implant-supported prostheses in the edentulous jaw. *Clin Oral Implants Res.* 1995;6:172–180.

43. Schiffleger BE, Ziebert GJ, Dhuru VB, et al. Comparison of accuracy of multi unit one-piece castings. *J Prosthet Dent.* 1985;54:770–776.

44. Clelland NL, Papazoglou E, Carr AB, et al. Comparison of strains transferred to a bone stimulant among implant overdenture bars with various levels of misfit. *J Prosthodont.* 1995;4:243–250.

45. Rangert B, Gunne J, Sullivan D. Mechanical aspects of Branemark implants connected to a natural tooth: An in vitro study. *Int J Oral Maxillofac Implants.* 1991;6:177–186.

46. Jemt T. In vivo measurements of precision fit of involving implant-supported prostheses in the edentulous jaw. *Int J Oral Maxillofac Implants.* 1996; 11:151–158.

47. Jemt T, Book K. Prosthesis misfit and marginal bone loss in edentulous implant patients. *Int J Oral Maxillofac Implants.* 1996;11:620–625.

48. Henry PJ. An alternative method for the production of accurate casts and occlusal records in the osseointegrated implant rehabilitation. *J Prosthet Dent.* 1987;58:694–7.

49. Goll GE. Production of accurately fitting full-arch implant frameworks: Part 1—Clinical procedures. *J Prosthet Dent.* 1991;66:377–384.

50. Loos L. A fixed prosthodontic technique for mandibular osseointegrated titanium implants. *J Prosthet Dent.* 1986; 55:232–242.

51. Clelland NL, Carr AB, Gilat A. Comparison of strains transferred to a bone stimulant between as-cast and post-soldered implant frameworks for a five-implant-supported fixed prosthesis. *J Prosthodont.* 1996;5:193–200.

52. Helldén LB, Dérand T. Description and evaluation of a simplified method to achieve passive fit between cast titanium frameworks and implants. *Int J Oral Maxillofac Implants.* 1998;13:190–196.

53. Rubenstein JE. Stereo laser-welded titanium implant frameworks: Clinical and laboratory procedures with a summary of 1-year clinical trials. *J Prosthet Dent.* 1995;74:284–93.

54. Jemt T, Bäck T, Petersson A. Precision of CNC-milled titanium frameworks for implant treatment in the edentulous jaw. *Int J Prosthodont.* 1999;12:209–215.

55. Jemt T, Lindén B. Fixed implant-supported prostheses with welded titanium frameworks. *Int J Periodontics Restorative Dent.* 1992;12:177–183.

56. Van Roekel NB. Prosthesis fabrication using electrical discharge machining. *Int J Oral Maxillofac Implants.* 1992; 7:56–61.

57. Jemt T, Rubenstein J, Carlsson L, et al. Measuring fit at the implant prosthodontic interface. *J Prosthet Dent.* 1996; 75:314–325.

58. Mulcahy C, Sheriff M, Walter JD, et al. Measurement of misfit at the implant-prosthesis interface: An experimental method using a coordinate measuring machine. *Int J Oral Maxillofac Implants.* 2000;15:111–118.

59. Jemt T. Three-dimensional distortion of gold alloy castings and welded titanium frameworks. Measurements of the precision of fit between completed implant prostheses and the master cast in routine edentulous situations. *J Oral Rehabil*. 1995;22:557–564.

60. Lie A, Jemt T. Photogrammetric measurements of implant positions. *Clin Oral Implants Res.* 1994;5:30–36.

61. Jemt T, Bäck T, Petersson A. Photogrammetry—An alternative to conventional impressions in implant dentistry? A clinical pilot study. *Int J Prosthodont.* 1999;12:363–368.

62. Jemt T, Book K, Lie A, et al. Mucosal topography around implants in edentulous upper jaws. *Clin Oral Implants Res.* 1994;5:220–228.

63. Shillingburg HT, Hobo S, Whitsett LD. *Fundamentals of Fixed Prosthodontics,* 2nd ed. Chicago: Quintessence; 1981:27.

64. Cho GC, Chee WWL. Apparent intrusion of natural teeth under an implant-supported prosthesis: A clinical report. *J Prosthet Dent.* 1992;68:3–5.

65. Garcia LT, Oesterle LJ. Natural tooth intrusion phenomenon with implants: A survey. *Int J Oral Maxillofac Implants.* 1998;13:227–231.

66. Brunski JB, Puleo DA, Nanci A. Biomaterials and biomechanics of oral and maxillofacial implants: Current status and future developments. *Int J Oral Maxillofac Implants.* 2000;15:15–46.

67. Brånemark P-I, Zarb G, Albrektsson T. *Tissue Integrated Prostheses: Osseointegration in Clinical Dentistry.* Quintessence; 1985:11–77,129–145.

68. Schnitman PA, Wohrle PS, Rubenstein JE. Immediate fixed interim prostheses supported by two-stage threaded implants: Methodology and results. *J Oral Implantol.* 1990;16:96–105.

69. Schnitman PA, Wöhrle PS, Rubenstein JE, et al. Ten year results for Brånemark implants immediately loaded with fixed prostheses at implant placement. *Int J Oral Maxillofac Implants.* 1997;12:495–503.

70. Schnitman PA. Brånemark implants loaded with fixed provisional prostheses at fixture placement: Nine-year follow-up. *J Oral Implantol.* 1995;21:235.

71. Lekholm U, Zarb GA. Patient selection and preparation. In: Brånemark P-I, Zarb GA, Albrektsson T, eds. *Tissue Integrated Prostheses: Osseointegration in Clinical Dentistry.* Quintessence; 1985: 199–210.

72. Ma T, Nicholls JI, Rubenstein JE. Tolerance measurements of various implant components. *Int J Oral Maxillofac Implants.* 1997;12:371–375.

73. Phillips KM, Nicholls JI, Ma T, et al. The accuracy of three implant impression techniques: A three-dimensional analysis. *Int J Oral Maxillofac Implants.* 1994;9:533–540.

74. Assif D, Marshak B, Schmidt A. Accuracy of implant impression techniques. *Int J Oral Maxillofac Implants.* 1996;11:216–222.

75. Carr AB. Comparison of impression techniques for a five-implant mandibular model. *Int J Oral Maxillofac Implants.* l991;6:448–455.

76. Carr AB. Comparison of impression techniques for a two-implant 15-degree divergent model. *Int J Oral Maxillofac Implants.* 1992;7:468–475.

77. Vigolo P, Millstein PL. Evaluation of master cast techniques for multiple abutment implant prostheses. *Int J Oral Maxillofac Implants.* 1993;8:439–446.

78. Hulterström M, Nilsson U. Cobalt-chromium as a framework material in implant-supported fixed prostheses: A 3-year follow-up. *Int J Oral Maxillofac Implants.* 1994;9:449–454.

79. Carr AB, Stewart RB. Full-arch implant framework casting accuracy: Preliminary in vitro observation for in vivo testing. *J Prosthodont.* 1993;2:2–8.

*Reprint requests and correspondence to:*
Murat C. Çehreli, DDS, PhD
Gazi Mustafa Kemal Bulvari
61/11 TR 06570 Maltepe
Ankara, Turkey
E-mail: mcehreli@hotmail.com

# Abstract Translations [German, Spanish, Portuguese, Japanese]

***AUTOR(EN):*** Saime Sahin, D.D.S., Ph.D *, Murat C. Çehreli, D.D.D, Ph.D **. **Professor der Abteilung für Zahnprothetik, Fachbereich der Zahnheilkunde, Hacettepe Universität, Ankara, Türkei. ** Forschungsassistent, Abteilung für Zahnprothetik, Fachbereich der Zahnheilkunde, Hacettepe Universität, Ankara, Türkei. Schriftverkehr: Murat C. Çehreli, Gaz Mustafa Kemal Bulvari, 61/11 TR 06570 Maltepe, Ankara, Türkei. Teefon.: +90.312.324b 6146, Fax: +90.312.311 3741. eMail: mcehreli@hotmail.com*

***ZUSAMMENFASSUNG:*** Die aktuell in Kliniken und Labors angewandten Verfahren zur Stützapparaterstellung sind hinsichtlich eines perfekten passiven Sitzes des implantatgestützten festen Überbaus absolut unzureichend. Obwohl einige im Zusammenhang mit der Protheseerstellung stehenden Komplikationen mangelndem passivem Sitz zugeschrieben werden, sind die letztendlichen Auswirkungen auf den Implantierungserfolg strittig. Es gibt inzwischen vielversprechende klinische Ergebnisse zum vermehrten Einsatz fortschrittlicher Techniken zur Verbesserung des Stützapparatsitzes. Diese Abhandlung befasst sich mit dem passiven Sitz und dessen Begleitfaktoren bezüglich des abschließenden Sitzes implantatgestützter Stützapparate.

***SCHLÜSSELWÖRTER:*** schraubenfixierte Prothese, zementfixierte Prothese, Brückenfehlsitz, passiver Sitz.

***AUTOR(ES)***: Saime Sahin, D.D.S., Ph.D.*, Murat C. Çehreli, D.D.S., Ph.D.** **Profesor, Departamento de Odontología Protética, Facultad de Odontología, Hacettepe University, Ankara, Turquía. **Asistente de Investigación, Departamento de Odontología Protética, Facultad de Odontología, Hacettepe University, Ankara, Turquía. Correspondencia a: Murat C. Çehreli, Gaz Mustafa Kemal Bulvari, 61/11 TR 06570 Maltepe, Ankara, TURKEY. Teléfono: +90.312.324 6146, Fax: +90.312.311 3741. Correo electrónico: mcehreli@hotmail.com*

***ABSTRACTO***: Los procedimientos clínicos y de laboratorio empleados para la fabricación de armazones son inadecuados para proporcionar un calce pasivo absoluto para las superestructuras fijas apoyadas por el implante. Mientras que la ocurrencia de algunas complicaciones protéticas se atribuye a la falta de un calce pasivo, su efecto en el éxito de los implantes es cuestionable. No obstante, los resultados clínicos de más aplicaciones de tecnologías avanzadas para mejorar el calce del armazón parecen prometedoras. Este trabajo evalúa la importancia clínica del calce pasivo y de los factores que afectan al calce final de los armazones apoyados por implantes.

***PALABRAS CLAVES***: Prótesis retenida con tornillos, prótesis retenida con cemento, mal calce de la superestructura, calce pasivo.

***AUTOR(ES):*** Saime Sahin, D.D.S., Ph.D.*, Murat C. Çehreli, D.D.S., Ph.D, **. ** Professor, Dep. de Prostodontia, Faculdade de Odontologia, Universidade de Hacettepe, Ancara, TURQUIA. ** Assistente de Pesquisa, Dep. de Prostodontia, Faculdade de Odontologia, Hacettepe, Ancara, TURQUIA. Correspondências devem ser enviadas a: Murat C. Çehreli, Guz Mustafa Kemal Bulvari, 61/11 TR 06570 Maltepe, Ancara, TURQUIA. Telefone: +90.312.321.6146, Fax: +90.312.311.3741 e-mail: mcehreli@hotmail.com*

***SINOPSE:*** Os procedimentos laboratoriais e clínicos empregados na fabricação de estruturas são inadequados para oferecer um encaixe absolutamente passivo para estruturas fixas suportadas por implantes. Devido ao fato de que a ocorrência de algumas complicações prostéticas é atribuída à falta de um encaixe passivo, seu efeito no sucesso dos implantes é questionável. Além disso, os resultados clínicos do aumento de aplicações de tecnologia avançada para aprimorar o encaixe da estrutura se mostram promissores. Este ensaio faz uma revisão da acepção do encaixe passivo e dos fatores que afetam o encaixe final de estruturas suportadas por implante.

***PALAVRAS-CHAVES:*** prótese de retenção por parafuso, prótese de retenção por cimento, encaixe de superestrutura imperfeito, encaixe passivo.

# *インプラント補綴歯科学におけるパッシブ・フレームワーク・フィットの重要性：現状分析*

**著者：**サイメ・サヒン、DDS、PhD*、ムラット・C・クチレリ、DDS、PhD**

**概要：**臨床・ラボの双方で使われているフレームワーク組み立て法は、インプラント支持による固定スーパーストラクチャーの完全なパッシブ・フィットの達成には不十分である。補綴に伴う合併症の一部は不完全なパッシブ・フィットに起因するものとされることが多い。これがインプラントの成功に必ずしも悪影響を与えるとは言いきれないものの、最新技術のより多用によって、フレームワークフィットの臨床結果は改善できそうである。本論文はパッシブ・フィットの臨床的重要さと、インプラント支持フレームワークの最終的フィットに影響を与える要因を再確認する。

**キーワード：**ねじ固定型補綴、セメント固定型補綴、スーパーストラクチャーのミスフィット、パッシブ・フィット

---

**ハセッテーペ大学（トルコ国アンカラ）歯学部補綴歯科学部教授*
***ハセッテーペ大学（トルコ国アンカラ）歯学部補綴歯科学部研究助手*

*問い合わせ先：Murat C. Çehreli, Gaz Mustafa Kemal Bulvari, 61/11 TR 06570 Maltepe, Ankara, TURKEY*
*電話：+90.312.324 6146　ファックス：+90.312.311 3741　E-メール：mcehreli@hotmail.com*