Occlusal Stability in Implant Prosthodontics — Clinical Factors to Consider Before Implant Placement

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Abstract

The success of any prosthetic design depends on proper management of the occlusion. The clinical variables influencing occlusal stability must be determined and considered in the design of the final prosthesis. This paper outlines some of these variables.

MeSH Key Words: *biomechanics; dental prosthesis design; dental prosthesis, implant-supported; stress, mechanical*

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Occlusal Diagnosis

Dental implant-supported restorations may develop complications for different reasons: some biological in origin[1,2] (Fig. 1) and others mechanical. The prosthetic design should respect the biomechanical factors that can contribute to prosthetic complications. Occlusal stability is achieved when the variables contributing to failure are identified and corrected or compensated for in the final prosthetic design.

The most significant factor affecting stability is occlusal loading. Excess loading may lead to loosening of abutment screws[3,4] and, if undetected, to possible fracture. Overloading may also damage the implant[5] (Fig. 2) and superstructure and lead to loss of osseointegration.[6] Overloading may occur if the implant prosthesis is designed with inadequate implant-fixture support under normal occlusal loading. The key is to place a sufficient number of implants to support the prosthesis.[7] The conventional ratio of implant to prosthetic unit is 1:1 (Fig. 3). However, for posterior restorations, the ratio may vary. Variable bone quality or lack of bone width may require 2 implants per unit molar replaced.[8] Two implants can be placed in narrower ridges and will provide greater antirotational and occlusal support and an increased surface area for osseointegration. Two implants positioned off angle will also provide counter support and reduce stress on the angled abutment screws.[9]

If the ridge height is diminished, the use of a standard-diameter short implant (<10 mm) is not usually recommended in posterior restorations (Fig. 4). A wide-diameter implant (Fig. 5) may provide adequate surface area for osseointegration and provide an alternative for support.[10] Ridge diameter, bone height and quality will be determining variables. The width of the proposed restoration will also dictate the amount of support required. The wide-diameter implant provides a larger abutment screw connection (for strength)[11] and a wider implant table for occlusal support. The wide-diameter implant has gained popularity in cases where the edentulous area does not provide space for 2 standard-diameter implants, and a single standard-diameter implant has been determined to be inadequate for support.

Abnormal occlusal forces, such as those caused by bruxism or clenching, may also contribute to prosthetic complications.[12] These habits are not a contraindication for implant dentistry, but must be diagnosed and compensated for in the final prosthetic design. The use of adjunctive protective guards is mandatory.

The stability of existing teeth must also be confirmed before placement of any fixed partial implant-supported prosthesis. Any mobility in the existing dentition must be diagnosed and corrected. Clinical mobility of existing dentition will result in added occlusal strain on the implant-supported prosthesis. The presence of any interocclusal interferences must also be corrected. Frequently these

Figure 1: Radiograph demonstrating bone loss due to peri-implantitis.

Figure 2: Radiograph showing a fractured implant.

Figure 3: Bridge demonstrating 1:1 implant-to-crown ratio.

Figure 4: Bone loss around a short dental implant.

Figure 5: Wide-body implant fixture to replace molar tooth.

are detected too late and compromise the occlusal design of the new prosthesis. Stable centric contacts, good excursive guidance of choice and sound periodontal support is required to achieve a stable occlusion.

Occlusal Design and Guidance

Occlusal design in partial fixed-implant-supported prosthetics is based on conventional restorative principles. The key is to provide proper anterior excursive guidance. Minimize any lateral forces on any implant-supported prosthesis, especially in the posterior area (where lateral forces are greater).[13] For anterior fixed partial prosthetics, this may be difficult. The occlusion on any anterior implant-supported prosthesis should obtain guidance from the existing anterior or posterior dentition (anterior disclusion, canine guidance or group function occlusal philosophies) which provide proprioceptive feedback, helping to control the intensity of lateral forces.

For complete arch fixed prostheses, the occlusal design is much more complicated and controversial. Occlusal guidance will depend on implant size, number, location, angulation, quality of bone, characteristics of opposing dentition, parafunctional history and occlusal characteristics.

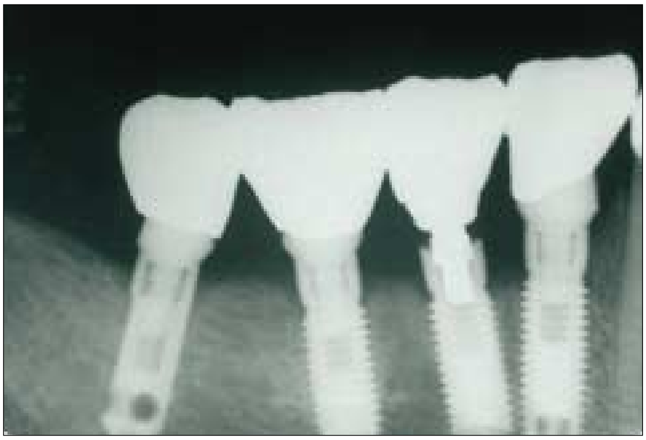

Figure 6: *Ill-fitting posterior bridge and prosthetic design.*

Figure 7: *Non-ideal cantilever: long distal cantilever demonstrating bone loss and poor support.*

Figures 8: *Ideal cantilever: mesial cantilever implant prosthesis.*

Figures 9: *Radiographic view of restoration in* **Figure 8**.

The provisional stage of implant therapy is critical in diagnosing the static and dynamic variables of occlusion.[14] A fixed detachable provisional model will help determine occlusal habits that are not readily identifiable otherwise. These can be corrected and compensated for in the final prosthesis. The provisional stage will also be a testing ground for your occlusal hypothesis.[15] Abutment selection, length, contour of the restoration and size of the occlusal table will all influence the occlusal design.

Prosthetic Design

Not all patients can be treated with the same type of restoration or design. In certain cases, a screw-retained prosthesis may be preferred; in others, a cemented prosthesis may be appropriate. Variables such as esthetics, occlusion, angulation of implants, mechanism of retrievability or implant location will guide the design of the prothesis.

The key to a stable implant/prosthesis relationship is to achieve a passive fit[16] of the framework during try-in. A non-passive fit will create stresses[17] in the connecting and abutment screws and on the implant.[18] This can lead to premature screw failure, damage to the prosthesis and complications of osseointegration. A positive correlation exists between the discrepancy of fit and stress in the prosthesis.[19] Proper seating of abutments or impression copings before impressions will minimize clinical and laboratory complications[20] (Fig. 6). Laboratory technique should minimize casting shrinkage and inaccuracies, and a non-passive framework try-in technique should achieve a stable and passive fit.[21]

The cantilever prosthesis has been used in prosthodontics with guarded success for many years. This design has had a resurgence in implant dentistry.[22] Frequently it is not possible to achieve an implant-to-prosthetic-unit ratio of 1:1 for anatomical reasons. In posterior sextant implant-supported restorations, a distal cantilever prosthesis is common. The lack of quality and quantity of bone in the posterior sextants has created the need for this design. Cantilevers must be used with caution[23] (Fig. 7). The weakest link in the cantilever design is the location and size of the pontic and the intensity of occluding masticatory forces.[24] These forces tend to be greatest in distally located pontic cantilevers.[25] A mesial cantilever is favoured over a distal cantilever for this reason

Figures 10: *Non-ideal cantilever: long anterior cantilever due to poor implant location, incorrect prosthetic work-up, inadequate lip support and compromised design. Incisal loading will lead to prosthetic failure.*

Figures 11: *Lateral view of restoration in* ***Figure 10****.*

(Figs. 8 and 9). A narrow occlusal table is recommended for the pontic.

An overcontoured anterior or posterior restoration will also act as a cantilever and increase stress within the framework during loading (Figs. 10 and 11). The abutment selection should compensate for minor irregularities in implant angulation to help compensate for occlusal factors. A wider occlusal table will increase stress on the abutment screws. Severe angulation problems may be a contraindication for a fixed-type of implant-supported prosthesis.

A significant improvement in abutment-implant stability has been achieved with preloading or torquing of components. Hand torquing has been shown to be unreliable,[26] but mechanical torquing has proven to be predictable and has significantly reduced loosening of implant components. The torque wrench is now the standard for insertion and tightening of implant components. Several abutment systems available today clearly indicate the amount of torque that is required for proper stabilization.

Conclusion

Occlusion has been an important variable in the success or failure of most prosthodontic reconstructions. With natural teeth, a certain degree of flexibility permits compensation for any occlusal irregularities. Implant dentistry is not as forgiving. The status of the occlusion must be properly diagnosed, corrected or compensated for, and properly integrated into the design of the definitive restoration. The occlusion must be more rigorously evaluated with implant-supported prosthodontics adjacent to natural dentition. ◆

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References

1. Becker W, Becker BE, Newman MG, Nyman S. Clinical and microbiological findings that may contribute to dental implant failure. *Int J Oral Maxillofac Implants* 1990; 5(1):31-8.

2. Salcetti JM, Moriarty JD, Cooper LF, Smith FW, Collins JG, Socransky SS, and other. The clinical, microbial, and host response characteristics of the failing implant. *Int J Oral Maxillofac Implants* 1997; 12(1):32-42.

3. Hurson S. Practical clinical guidelines to prevent screw loosening. *Int J Dent Symp* 1995; 3(1):22-5.

4. Dixon DL, Breeding LC, Sadler JP, MacKay ML. Comparison of screw loosening, rotation, and deflection among three implant designs. *J Prosthet Dent* 1995; 74(3):270-8.

5. Morgan MJ, James DF, Pilliar RM. Fractures of the fixture component of an osseointegrated implant. *Int J Oral Maxillofac Implant* 1993; 8(4):409-14.

6. Davies JE. Mechanisms of endosseous integration. *Int J Prosthodont* 1998; 11(5):391-401.

7. Davidoff SR. Restorative-based treatment planning: determining adequate support for implant-retained fixed restorations. *Implant Dent* 1996; 5(3):179-84.

8. Bahat O, Handelsman M. Use of wide implants and double implants in the posterior jaw: a clinical report. *Int J Oral Maxillofac Implants* 1996; 11(3):379-86.

9. Balshi TJ, Ekfeldt A, Stenberg T, Vrielinck L. Three-year evaluation of Brånemark implants connected to angulated abutments. *Int J Oral Maxillofac Implants* 1997; 12(1):52-8.

10. Becker W, Becker BE. Replacement of maxillary and mandibular molars with single endosseous implant restorations: a retrospective study. *J Prosthet Dent* 1995; 74(1):51-5.

11. Rangert B, Krogh PH, Langer B, Van Roekel N. Bending overload and implant fracture: a retrospective clinical analysis. *Int J Oral Maxillofac Implants* 1995; 10(3):326-34.

12. Perel ML. Parafunctional habits, nightguards, and root form implants. *Implant Dent* 1994; 3(4):261-3.

13. Rangert BR, Sullivan RM, Jemt TM. Load factor control for implants in the posterior partially edentulous segment. *Int J Oral Maxillofac Implants* 1997; 12(3):360-70.

14. Moscovitch MS, Saba S. The use of a provisional restoration in implant dentistry: a clinical report. *Int J Maxillofac Implants* 1996; 11(3):395-9.

15. Saba S. Anatomically correct soft tissue profiles using fixed detachable provisional implant restorations. *J Can Dent Assoc* 1997; 63(10):767, 8, 770.

16. Meijer HJ, Kuiper JH, Starmans FJ, Bosman F. Stress distribution around dental implants: Influence of superstructure, length of implants, and height of mandible. *J Prosthet Dent* 1992; 68(1):96-102.

17. Watanabe F, Unu I, Hata Y, Neuendorff G, Kirsch A. Analysis of stress distribution in a screw-retained implant prosthesis. *Int J Oral Maxillofac Implants* 2000; 15(2):209-18.

18. Binon PP. The effect of implant/abutment hexagonal misfit on screw joint stability. *Int J Prosthodont* 1996; 9(2):149-60.

19. Jemt T, Book K. Prosthesis misfit and marginal bone loss in edentulous implant patients. *Int J Oral Maxillofac Implants* 1996; 11(5):620-5.

20. Assif D, Fenton A, Zarb G, Schmitt A. Comparitive accuracy of implant impression procedures. *Int J Periodont Restorative Dent* 1992; 12(2):112-21.

21. Carr AB, Steward RB. Full-arch implant framework casting accuracy: preliminary in vitro observation for in vivo testing. *J Prosthodont* 1993; 2(1):2-8.

22. Becker CM, Kaiser DA. Implant-retained cantilever fixed prosthesis: where and when. *J Prosthet Dent* 2000; 84(4):432-5.

23. McAlarney ME, Stavropoulos DN. Determination of cantilever length-anterior-posterior spread ratio assuming failure criteria to be the compromise of the prosthesis retaining screw-prosthesis joint. *Int J Oral Maxillofac Implants* 1996; 11(3):331-9.

24. Shakleton JL, Carr L, Slabbert JCB, Becker PJ. Survival of fixed implant-supported prostheses related to cantilever lengths. *J Prosthet Dent* 1994; 71(1):23-6.

25. Rodriguez AM, Aquilino SA, Lund PS, Ryther JS, Southard TE. Evaluation of strain at the terminal abutment site of a fixed mandibular implant prosthesis during cantilever loading. *J Prosthodont* 1993; 2(2): 93-102.

26. Goheen KL, Vermilyea SG, Vossoughi J, Agar JR. Torque generated by handheld screwdrivers and mechanical torquing devices for osseointegrated implants. *Int J Oral Maxillofac Implants* 1994; 9(2):149-55.

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