Report of a Case Receiving Full-Arch Rehabilitation in Both Jaws Using Immediate Implant Loading Protocols: A 1-Year Resonance Frequency Analysis Follow-Up

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ABSTRACT

Background: Immediate occlusal implant loading has been documented as a viable treatment option for various indications. However, documentations related to full-arch rehabilitation are usually limited to treatment of one jaw at a time, thereby leaving the opposing dentition unchanged. Furthermore, clinical documentation using traditional, well-accepted measuring techniques may not be adequate when it comes to short-term evaluation of the success or failure of implants subjected to immediate occlusal loading.

Purpose: The purpose of this case report is to (1) present an implant stability follow-up of a patient receiving an immediate, implant-supported full-arch rehabilitation in both jaws and (2) evaluate the patient's acceptance of this rehabilitation.

Materials and Methods: A 68-year-old patient scheduled for implant treatment was selected for an immediate implant loading protocol in both jaws. During two surgical events 3 weeks apart, eight maxillary and four mandibular Brånemark System® Mk IV TiUnite™ fixtures (Nobel Biocare AB, Göteborg, Sweden) were inserted and subsequently used to immediately support a cross-arch fixed prosthesis in the maxilla and a bar-retained overdenture in the mandible. Implant stability was recorded from the day of surgery periodically during a 1-year follow-up using resonance frequency analysis (RFA).

Results: At the 1-year follow-up, based on clinical, RFA, and radiographic evaluations, all implants and the reconstructions were classified as successful. All maxillary implants showed a decrease in the implant stability quotient (ISQ) value from the measurement at the time of surgery to the first follow-up, whereas two of four mandibular implants revealed an initial drop in stability. Irrespective of a specific ISQ level measured at implant surgery (ISQ range 53–74) and despite an initial decrease in stability, measurements recorded at the 12-month follow-up indicated similar stability levels for all maxillary implants (ISQ range 64–68) or the group of mandibular implants (ISQ range 72–75) but with a higher ISQ level for mandibular implants. Furthermore, the patient's acceptance of the immediate full-arch rehabilitation in both jaws was high.

Conclusions: The present case report demonstrates that a slightly staged approach for full-arch rehabilitation in both jaws using immediate implant loading protocols is a realistic treatment option. Furthermore, RFA follow-up indicates that immediately occlusally loaded implants placed in reduced bone quality and quantity are more prone to loose stability in the early healing period compared with implants placed in dense bone quality.

KEY WORDS: Brånemark dental implants, immediate loading, primary stability, resonance frequency analysis, secondary stability

Immediate occlusal implant loading has been documented as a viable treatment option for implants supporting cross-arch fixed restorations[1–10] or bar-retained overdentures.[11–15] Usually, such full-arch rehabilitations

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DOI 10.2310/6480.2005.00027

Figure 1 Preoperative orthopantomogram.

are performed only in one jaw at the same time. However, if a patient needs implant-supported rehabilitation in both jaws, a comprehensive therapy including the treatment strategy for both arches is indicated. Furthermore, from the patient's perspective, immediate rehabilitation of both jaws using immediate implant loading protocols could be considered the ultimate treatment challenge and thereby increase patient's acceptance.

Moreover, a clinical implant evaluation using traditional, well-accepted diagnostic techniques (eg, radiographic evaluation, peri-implant probing, percussion test on abutment level) may not be adequate when it comes to a quantitative, short-term assessment of the stability of implants subjected to immediate occlusal loading in both jaws. Therefore, it would be of interest to follow osseointegration of immediately loaded implants in terms of changes in stability during the early healing period.

It has been reported for one-stage Brånemark System® implants (Nobel Biocare AB, Göteborg, Sweden) placed in dense bone and followed using resonance frequency analysis (RFA) according to Meredith[16] and colleagues that implant stability most often did not increase during healing but rather slightly decreased.[17] On the other hand, it has been documented by using a twostage protocol for maxillary implants that soft bone sites often develop increased anchorage over time, as measured using the RFA technique.[18] At present, comparable data for implants subjected to immediate occlusal loading in both jaws and followed during the early healing period have not yet been published.

The aim of this 1-year case follow-up was to (1) evaluate the implant stability of immediately occlusally loaded Brånemark System Mk IV TiUnite™ fixtures (Nobel Biocare AB, Göteborg, Sweden) placed in various bone conditions in both jaws using the RFA technique and (2) evaluate the patient's acceptance of full-arch rehabilitation in both jaws using immediate implant loading protocols.

MATERIALS AND METHODS

A partially edentulous, 68-year-old male patient was referred for an evaluation for dental implants to support either a fixed or a removable reconstruction in both the mandible and the maxilla. Based on clinical and radiographic diagnostics (Figure 1), a cross-arch complete fixed denture supported by eight implants was planned to reconstruct the maxillary dentition, whereas a bar-retained overdenture supported by four fixtures was selected for the mandible. Since extraction of all remaining teeth and implant surgery in both jaws were performed under local anesthesia, the patient's limitations with regard to physical constitution and overall allowed dosage of anesthetic finally resulted in two separate surgical events for maxillary and mandibular rehabilitation 3 weeks apart. Implant surgery in both jaws was performed according to a previously described protocol.[19] Overall, eight maxillary and four mandibular Brånemark System Mk IV TiUnite implants were placed in a restoration-driven position (Figures 2 and 3) and restored on the day of implant surgery. The maxillary reconstruction consisted of a screw-retained, fiberreinforced, acrylic-veneered provisional fixed prosthesis. In the mandible, an ovoid gold bar was connected to the implants to support a provisional overdenture. Postoperative healing was uneventful (Figures 4 to 6). At different time points during the following 12 months of

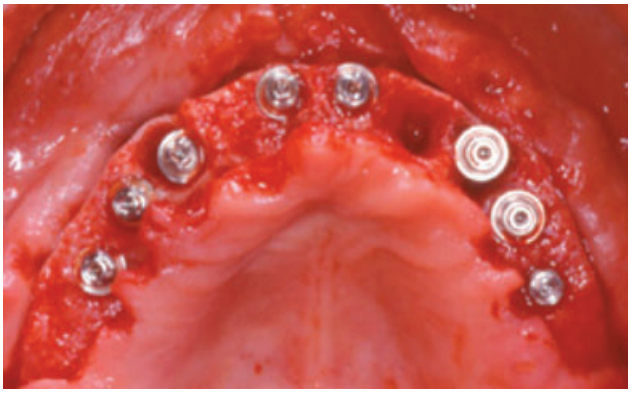

Figure 2 Occlusal view of maxillary implants connected intraoperatively to Multi-Unit® abutments (Nobel Biocare AB, Göteborg, Sweden).

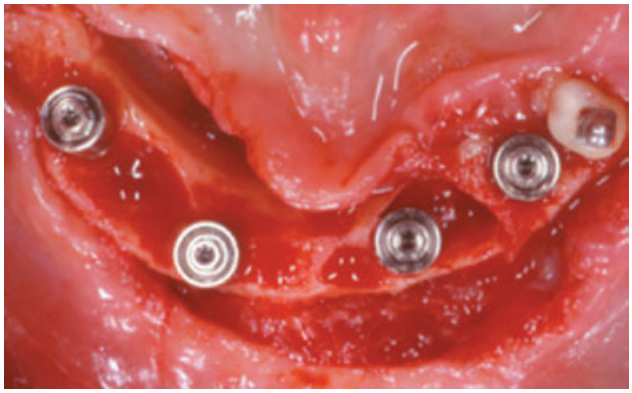

Figure 3 Occlusal view of mandibular implants with standard abutments mounted. The remaining root in position 35 was extracted following bite registration.

Figure 5 Maxillary implants at the 12-week follow-up.

implant loading, the prosthetic reconstructions were removed and mandibular and maxillary implants were individually evaluated using the RFA technique (Osstell^{TM}, Integration Diagnostics, Sävedalen, Sweden) to identify possible changes in implant stability over time. RFA measurements on abutment level were performed for maxillary implants immediately after fixture placement, at 2 weeks, and at 1, 2, 3, 4, 6, 9, and 12 months. For mandibular implants, the RFA measurements were performed at surgery and at 1, 2, 3, 4, 5, 6, 8, and 12 months.

RESULTS

The localization of maxillary and mandibular implants and characteristics of the corresponding sites are listed in Table 1. The slightly staged surgical approach between maxillary and mandibular rehabilitation was well accepted by the patient. Moreover, speech and functional adaptation to the new prosthetic reconstructions was established already within the first few weeks. At the 1-year follow-up, based on clinical, RFA, and radiographic evaluations, all implants and the reconstructions were classified as successful.

The results of the RFA measurements expressed in ISQ (implant stability quotient) values over time are presented for maxillary and mandibular implants in Figures 7 and 8, respectively. Mean ISQ values calculated for the groups of maxillary and mandibular implants are presented in Figure 9. All maxillary implants showed a decrease in ISQ value from the measurement at the time of surgery to the first follow-up, whereas only two of four mandibular implants revealed an initial drop in stability.

Irrespective of a specific ISQ level measured at implant surgery (ISQ range 53–74) and despite an initial decrease in stability, measurements recorded at the 12-month follow-up indicated similar stability levels for all maxillary implants (ISQ range 64–68) or the group of mandibular implants (ISQ range 72–75). Furthermore, RFA on 11 of 12 implants indicated

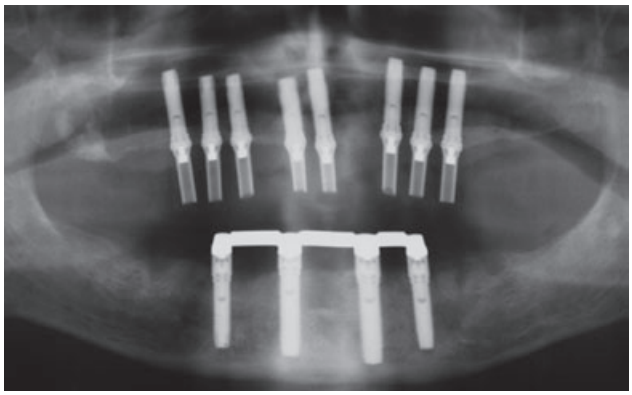

Figure 4 Orthopantomogram at the 4-week follow-up.

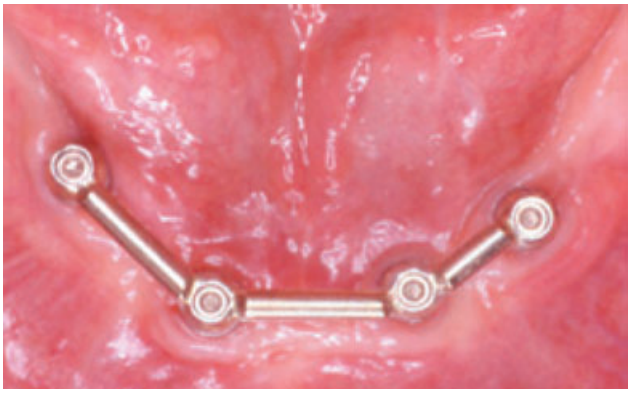

Figure 6 Mandibular implants at the 12-week follow-up with an ovoid gold bar in situ.

TABLE 1 Localization of Maxillary and Mandibular Implants with Corresponding Characteristics of the Recipient Sites

Time point of fixture placement*		3	3	1		3	3		2	3	3	
Bone defect and GBR procedure		No	No	Yes		No	No		Yes	No	No	
Bone quantity†		B	B	B		B	B		C	B	B	
Bone quality†		4	4	3		3	3		4	4	4	
Implant surface		T	T	T		T	T		T	T	T	
Type of implant		IV	IV	IV		IV	IV		IV	IV	IV	
Implant diameter		RP	RP	RP		RP	RP		RP	RP	RP	
Implant length (mm)		15	13	13		13	15		15	15	15	
Position	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**
Position	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**
Implant length			15		18			18		18		
Implant diameter			RP		RP			RP		RP		
Type of implant			IV		IV			IV		IV		
Implant surface			T		T			T		T		
Bone quality†			2		2			2		2		
Bone quantity†			C		B			C		C		
Bone defect and GBR procedure			Yes		No			Yes		Yes		
Time point of fixture placement*			3		3			3		1		

GBR = guided bone regeneration; IV = Brånemark System Mk IV fixture; RP = regular platform; T = TiUnite.
*1 = immediate placement; 2 = delayed placement; 3 = late placement.
†According to Lekholm and Zarb.[28]

a similar or higher ISQ value at the 1-year follow-up compared with the corresponding baseline measurement.

DISCUSSION

There is limited information available on the stability of implants placed in both opposing jaws and subjected to immediate occlusal loading. Moreover, in complete edentulism, no load control through remaining teeth is possible and the loading conditions for such implants might be more critical. In the present case, the recorded stability behaviors over time indicate that implants placed in soft bone conditions and/or in combination with bone defects showed a more or less pronounced stability loss in terms of a decrease in ISQ values during the early weeks following surgery compared with

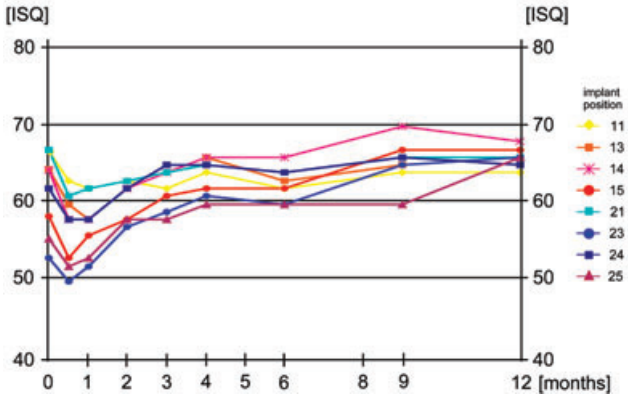

Figure 7 Resonance frequency analysis expressed in implant stability quotient (ISQ) values for all maxillary implants (n = 8) measured at surgery (0), at 2 weeks, and at 1, 2, 3, 4, 6, 9, and 12 months.

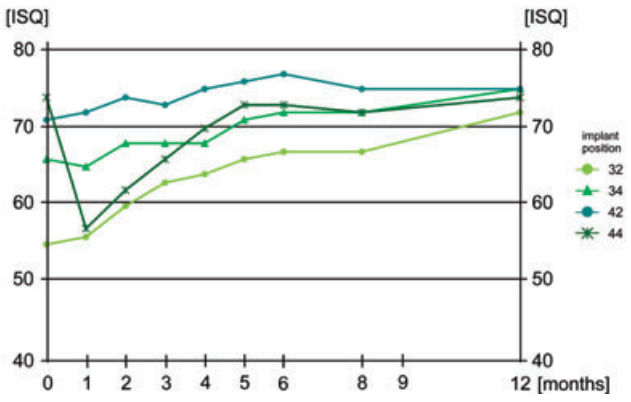

Figure 8 Resonance frequency analysis expressed in implant stability quotient (ISQ) values for all mandibular implants (n = 4) measured at surgery (0), and at 1, 2, 3, 4, 5, 6, 8, and 12 months.

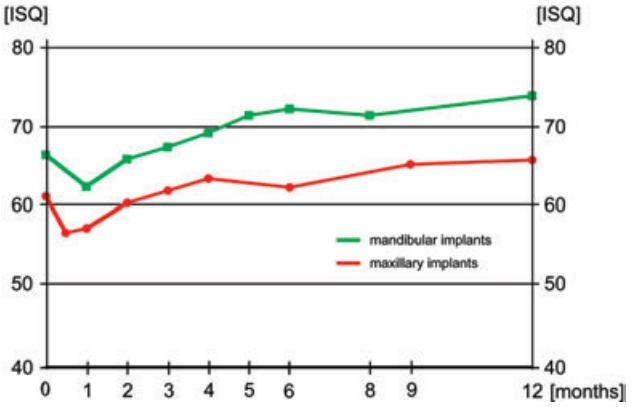

Figure 9 Mean implant stability quotient (ISQ) values for maxillary (*red*) and mandibular (*green*) implants plotted over time.

implants inserted in dense bone. In general, a change in implant stability (ie, ISQ values) over time reflects alterations in stiffness at the bone-implant interface as a result of bone resorption, formation, and maturation.[16,17,20,21] An early drop in stability recorded for 10 of 12 implants up to 2 to 4 weeks indicates that, initially, interfacial resorption may be a dominant factor. Furthermore, it is obvious that under full and immediate loading conditions, the loading per se will also interact along a specific bone-implant interface, thereby influencing interfacial stiffness more or less pronounced from the first day. On the other hand, it can be speculated that splinting of all mandibular and maxillary implants with a rigid prosthetic reconstruction probably decreased the amount of micromotion at the boneimplant interface, thereby also limiting the amount of stability change in the early healing stage.

During the monitoring period of the first 12 months of occlusal loading, an initial loss of primary stability was followed by a re-increase in stability for 10 of 12 implants. Moreover, the stability of maxillary implants followed in this case analysis is in line with RFA data published for immediately occlusally loaded Brånemark Mk IV implants placed in the posterior maxilla.[22] Based on a comparison of Mk IV implants exhibiting either a machined or an oxidized surface, it was found that the textured surface maintained implant stability better in the early healing period. In general, stability loss can result in excessive relative micromovement at the boneimplant interface that will prevent bone formation and may result in non-rigid fixation by fibrous tissue.[23–25] Therefore, selecting an implant surface that helps reduce the risk of a stability loss in the early healing period is beneficial in terms of successful osseointegration under immediate loading conditions.

In the present case, the ISQ values of maxillary and mandibular implants levelled at the 12-month check-up with the other implants placed within the same jaw, irrespective of implant length, bone conditions, or the stability level measured at the time of implant placement. This finding is in harmony with RFA data published for maxillary Brånemark implants placed in a two-stage protocol and followed for 1 year of prosthetic loading[18] and with a report on stability measurements of one-stage Brånemark implants during healing in mandibles.[17] Mandibular implants placed in the present case showed a tendency toward reaching a higher stability level at the time of implant placement (ie, primary stability) compared with implants placed in the upper jaw. As primary implant stability is determined by the bone properties, implant design and surgical technique,[26] it may be concluded that differences in bone density found between mandibular (bone quality type 2) and maxillary sites (bone quality type 3 or 4) may have also influenced the primary stability as measured in ISQ values. Furthermore, the stability levels measured at 12 months for mandibular implants (mean ISQ 74; range 72–78) were slightly higher than stability levels evaluated for maxillary implants (mean ISQ 66; range 64–68). It has been stated that implant anchorage is the effect of the initial anchorage (ie, primary stability) and any subsequent bone formation and remodeling (ie, secondary stability).[27] RFA data published for maxillary[18] and mandibular[17] Brånemark implants indicated that in dense bone sites, the initial measured stability most often did not change, whereas in soft bone sites, an increase in stability owing to new bone formation could be observed. The stability follow-up of mandibular implants in the present case reveals that also in dense bone quality (type 2) an increase in stability during the first 12 months of function is possible. It can be speculated that such an increase in stability in dense bone sites may be, at least in part, related to an implant surface effect because the above-mentioned studies were all conducted using machined-surfaced implants.

With regard to different available treatment modalities, immediate rehabilitation of both jaws simultaneously using immediate implant loading protocols could be considered the ultimate treatment challenge. However, if such a therapy is conducted under local anesthesia, the majority of elderly patients with a need

for full-arch rehabilitation in both jaws will not allow for such a simultaneous bi-maxillary approach because of limitations with regard to physical constitution and overall allowed medication. Moreover, a simultaneous approach in both jaws will complicate and delay the immediate prosthetic rehabilitation and may also jeopardize its precision. On the other hand, the slightly staged rehabilitation selected in the present case was well appreciated by the patient and allowed for establishing proper speech and function within a very short period.

CONCLUSIONS

Within the limitations of this case report, the following conclusions can be drawn:

1. Irrespective of a rigid implant splinting through the prosthetic reconstruction, immediately occlusally loaded implants placed in reduced bone quality and quantity are more prone to loose stability in the early healing period compared with implants placed in dense bone.
2. Bi-maxillary full-arch rehabilitation using immediate implant loading protocols can be successfully applied by selecting a slightly staged approach between the jaws.

ACKNOWLEDGMENT

We thank Mrs. Ana Suter, CDT, for her great contribution to the innovative and fast prosthetic provisionalization of this case.

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