

A Retrospective Analysis of 44 Implants with No Rotational Primary Stability Used for Fixed Prosthesis Anchorage

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Purpose: The aim of this study was to determine the osseointegration potential of implants with apical primary stability but no resistance to rotation in variable clinical conditions. **Materials and Methods:** Patient records of treatment performed between October 1993 and May 2004 were reviewed for primary implant stability. Patients who exhibited implants without rotational primary stability (RPS) were reviewed further to determine patient age, gender, implant type, implant surface, loading protocol, and prosthesis type. **Results:** Forty-four implants without RPS were reported in 12.8% of patients treated during the period reviewed. Statistical significant differences in cumulative survival rate (CSR) were seen with implant location and surface. No significant difference in CSR was observed in relation to loading protocol, despite a higher success rate (17.4% higher) for the immediate loading population. No difference in CSR was observed with respect to gender. **Discussion and Conclusion:** In the early years of machined implants, there was a higher failure rate of implants without RPS. The results for this implant population show that there are statistically significant differences in survival rate between the maxilla and mandible, and also between titanium oxide-surfaced implants and machined implants. The sample size of this study limited the statistical significance of the difference in CSR observed between loading protocols. Implants without RPS that are not removed at the time of surgery can become osseointegrated with a survival rate of 82%. Survival rates increase when testing sample is limited to titanium oxide-surfaced implants under an immediate loading protocol. Under the appropriate level of risk, implants that have apical primary stability but no resistance to rotation can become osseointegrated when incorporated in a rigid prosthesis under immediate loading circumstances. (Case Series) *INT J ORAL MAXILLOFAC IMPLANTS* 2007;22:467-471

Key words: bone-implant interface, dental implants, immediate loading, implant stability

Implant stability has always been a requisite for long-term success of implant prosthodontic treatment.¹ The assessment of stability resulting in osseointegration can be divided into primary and secondary phases of stability. Primary stability is attained at implant placement and is determined by

numerous factors, including the density and mechanical properties of the bone, implant design,²⁻⁴ site complications,⁵ and surgical technique. Secondary stability depends on the further reaction of the surrounding tissue to the implant and is influenced by many factors, including bone vitality, healing potential, and the patient's medical and behavioral issues related to bone remodeling (eg, diabetes). Numerous reports with different clinical and technical parameters have been performed to understand the dynamics of primary and secondary stability.⁶⁻¹³

In some clinical situations, the primary stability of an implant is so high that a further increase in stability is not expected.¹⁴ These findings support the use of an immediate loading protocol. In other instances, the primary stability of an implant is low. Low primary stability may be caused by minimal bone density at the osteotomy site or by overpreparation of the osteotomy site by the clinician.

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This report focuses on implants that can be described as continuously rotating when the implant delivery device is removed and the cover screw or abutment is applied. This "rotational" action in the bone occurs without detectable lateral or apical movement. There is no frictional binding of the implant threads in the bone trabeculae in these cases.¹⁵

The purpose of this study was to gain insight into the secondary stability and osseointegration of implants without rotational primary stability (RPS). The survival rates of these implants were examined according to loading protocol, implant surface characteristics, implant location, and patient gender.

MATERIALS AND METHODS

Patient Selection

A retrospective review was conducted of all implant patients treated at Prosthodontics Intermedica (Fort Washington, PA) from October 1993 to May 2004. All pertinent information for each implant placed was entered into an implant tracking database system (Implant Tracker; Implant Tracking Systems, West Hartford, CT). During surgical implant placement, records were made of primary stability of implants or lack thereof. The records of all patients who exhibited a lack of RPS were reviewed to determine patient age, gender, implant type, implant surface, loading protocol, and prosthesis type.

Prosthetic Procedure

Patients were treated with either a conventional 2-stage loading protocol or a 1-stage immediate loading protocol. The choice of protocol was determined by the prosthodontists (ie, the authors of this report) at the time of implant placement. For immediately loaded implants, abutments were connected, and a screw-retained acrylic-resin fixed prosthesis was placed within 1 hour of implant placement. All patients were instructed to maintain a soft diet for the first 12 weeks or until the definitive porcelain-fused-to-gold prosthesis was delivered. The screw-retained acrylic-resin fixed prosthesis was not removed during the initial healing period until such time as master impressions were made for the construction of the definitive prosthesis.

All patients following the 2-stage conventional loading protocol underwent uncovering surgery after implant placement. The abutments were connected at this time, and the implants were subjected to loading forces via a conversion prosthesis. A definitive prosthesis was constructed and delivered within 3 weeks following abutment connection. Therefore, all patients in this report, regardless of whether they

were treated by means of a 1- or 2-stage loading protocol, received their definitive prostheses approximately 3.5 to 4 months after implant placement.

Prior to the making of master impressions, all implants were manually and visually evaluated for stability. All mobile implants were removed at this time.

Statistical analysis was performed using analysis of variance (ANOVA) to assess whether survival rates differed according to implant location, implant type, and loading protocol. $P < .05$ was considered statistically significant.

RESULTS

During the course of study, 305 patients were treated with dental implants. Of these 305 patients, 39 (12.8% of the study sample) failed to exhibit RPS for 1 or more implants. These 39 patients (30 female, 9 male) had a mean age of 58.5 years (range, 29 to 82 years) and were in need of partial or complete implant reconstruction.

Four hundred fifty-nine Brånemark System implants (Nobel Biocare USA, Yorba Linda, CA) were used to treat the 39 patients in this study; all were placed in healed bone or fresh extraction sites. An average of 12 implants (range, 4 to 22 implants) was placed in each patient.

Forty-four of the 459 implants placed in these 39 patients had apical primary stability, but not resistance to rotation. Thirty of these 44 implants were placed in the maxilla; the remaining 14 implants were placed in the mandible. For 34.1% (15 of 44) of this implant population, abutments were connected immediately following implant insertion, prior to flap closure, and a Teeth in a Day (TIAD) prosthesis was made as previously described in the literature,^{16,17} thereby immediately loading each implant. The remaining 65.9% (29 of 44) were submerged for a healing period of approximately 3 months at the clinician's discretion. Thirty-three (75%) implants without RPS were noted in female patients, and 11 (25%) were noted in the male population. It is the authors' observation that all implants without RPS in this report occurred in patients with bone qualities of type 3 or 4 according to the classification described by Lekholm and Zarb.¹⁸

Since the inception of the TiUnite surface implant in patient treatment at Prosthodontics Intermedica in December 1999, 24 implants without RPS have been recorded with this titanium oxide surface. Before December 1999, the 20 implants without RPS had the standard machined surface.

Four hundred eighteen of the 459 implants placed in these 39 patients became osseointegrated,

Table 1 Cumulative Survival Rates

Years	No. of implants	No. of failed implants	Survival rate for period (%)	CSR (%)
0 to 1	44	7	84.1	84.1
1 to 2	32	0	100.0	84.1
2 to 3	29	0	100.0	84.1
3 to 4	24	1	95.8	82.0
4 to 5	20	0	100.0	82.0
5+	18	0	100.0	82.0

for a cumulative survival rate (CSR) of 91.1%. Of the 44 implants without RPS, 36 implants became osseointegrated, for a CSR of 82.0% (Table 1). The remaining 415 implants with RPS had a CSR of 92.0%.

This implant population without RPS had a 73.3% survival rate (22 of 30) in the maxilla and a 100.0% survival rate (14 of 14) in the mandible; the difference between jaws was statistically significant ($P < .05$). The immediately loaded implant population without RPS ($n = 15$) had only 1 failure, for a CSR of 93.3%, while the 29 implants placed with the conventional 2-stage approach had a survival rate of 75.9% (Table 2). Although there was a 17.4% difference, the difference was not statistically significant at this sample size ($P < .05$). In the 30 female patients with implants without RPS, 27 of 33 implants became osseointegrated (82.0% survival rate). The 9 male patients, who accounted for the remaining 11 implants without RPS, had an equivalent survival rate of 82.0% (9 of 11).

The machined-surface implant population without RPS had a survival rate of 70.0% (14 of 20). The titanium oxide-surfaced implant population, introduced in December 1999 and clinically used since that time, had a survival rate of 91.7% (22 of 24; Table 2). This 21.7% difference was statistically significant ($P < .05$). All 39 patients experienced a prosthesis survival rate of 100% for an average of 4.05 years (range, 6 months to 11 years).

Seven of the 8 implant failures observed occurred in the first year after placement and were noted at either second stage surgery (for 2-stage protocols) or final impression (for immediate loading protocols). The eighth failure, a 4×10 machined-surface implant placed in at the site of maxillary left second molar occurred 46 months after placement (Table 1).

Table 2 Cumulative Survival Rates by Location, Loading Type, and Implant Surface

	CSR (%)	No. placed
Maxilla		
2-stage		
Machine	42.1	12
TiUnite	75.0	8
1-stage		
Machine	66.7	3
TiUnite	100.0	7
Mandible		
2-stage		
Machine	100.0	5
TiUnite	100.0	4
1-stage		
Machine	–	0
TiUnite	100.0	5

DISCUSSION

It has consistently been reported that primary stability is related to successful dental implant rehabilitation. This study reports the use of 44 implants that have apical primary stability but no resistance to rotation. The principal reason that an implant may fail to develop RPS is low bone density. Lack of RPS occurs when the mineralization of the bone is diminished, and the bone provides insufficient anchorage. A second clinical situation where lack of RPS may result is the placement of an implant in an immediate extraction socket (a space larger than the implant itself). Inexperienced clinicians may either overprepare the osteotomy site, which strips the site, or apply an unnecessary level of torque, breaking the bone around the implant.

The data in this report agree with the observation that higher success rates are shown in the mandible than the maxilla.⁶ Since the bone is often denser in the mandible than the maxilla, this data also supports other documented studies that have shown a connection between initial bone density and osseointegration rates.^{11–13} These other studies reported that higher failure rates are associated with poor initial bone quality.

Immediate loading protocols, like the one used in this report,¹⁶ have shown comparable results to the conventional 2-stage approach in cases where primary stability is favorable.¹⁹ In the present study, the immediate loading protocol yielded a 17.4% higher survival rate than the traditional 2-stage protocol for implants without RPS. Although no significant difference in CSR was found with respect to loading protocol, a significant difference in CSR was found between the titanium oxide and machined surfaces, and the use of these 2 surfaces evolved in conjunc-

tion with the use of the immediate loading protocol. The roughness of the titanium oxide surface means that it has greater surface area; the surface also exhibits an osseointegrative nature (ie, it attracts growth factors and proteins associated with the onset of osseointegration). The combination of high success rates with immediate loading protocols and the increased survival rates seen with the titanium oxide-surfaced implants⁷⁻¹⁰ has led to the immediate loading of implants with a lower primary stability while maintaining a reasonably high level of osseointegration. It was calculated that if the sample size were doubled to 88 implants, with identical survival rates, the CSR for the 1-stage loading protocol would have been significantly greater than that of the 2-stage protocol ($P < .05$).

Since micromotion interrupts or inhibits osseointegration,²⁰ one might glean from this data that the immediate loading protocol employed in this report appears to provide sufficient stability to both the implant and prosthesis to inhibit implant movement during the initial critical bone healing period. At the same time, with a 2-stage protocol, one should consider that an interim removable prosthesis supported by the mucosa could cause an individual implant to be loaded in an isolated circumstance, which could create overload-producing micromotion leading to fibrous encapsulation.

Nevertheless, certain implants without RPS were selected for the immediate loading protocol, while others were submerged for a healing period in the 2-stage protocol. Experienced clinicians can identify the appropriate risk levels associated with immediate loading for each implant. For example, it may be reasonably safe to immediately load an implant without RPS when the implant is placed in between 2 other implants that have high primary stability and it is stabilized by a rigid prosthetic device. An implant located in a structurally critical support region, such as the most distal implant in the posterior maxilla, has a higher level of risk and may be submerged for the duration of the critical healing period if the prosthesis cannot be constructed so as to provide sufficient rigidity. This condition frequently arises when pterygomaxillary implants are incorporated into the prosthetic design, because anatomy constraints often limit the vertical height and volume of the prosthetic materials. A thin distal bar extension can create a springboard effect on the most distal implant. The rationale is to eliminate future cantilevers, which are often times associated with detrimental off-axis loading. Single-tooth implants without RPS are another clinical scenario where an immediate loading protocol may be considered too risky.

This study does not, however, identify when implants without RPS become osseointegrated. The points of testing in this study were either at second-stage surgery (for a 2-stage protocol) or at final impression (for the TIAD protocol). Therefore, sometime before 4 months, the implants without RPS that remain in function lose their rotational stability. Future studies should be conducted to identify the duration of the critical bone-remodeling period for these implants without applying a misfit strain on the implants that would increase the level of micromotion beyond the critical threshold described by Brunksi.²⁰ Resonance frequency analysis²¹ could be used to test the primary and secondary stability at multiple intervals to determine the stability pattern for this type of implant population.²²

CONCLUSION

This study, with a sample size of 44 implants without RPS, indicated a statistically significant difference between implants placed in the maxilla and the mandible and between machined implants and titanium oxide-surfaced implants. There was no statistical significance between the 2-stage and 1-stage loading protocols, although the 1-stage loading protocol demonstrated a higher survival rate. CSR did not differ significantly with respect to gender.

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