Treatment strategies in moderate atrophic posterior maxilla: short dental implants or sinus floor elevation?

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The aim of present study is to evaluate the implant stability, operative time and patient satisfaction of short dental implants (6mm) alone, short dental implants (8mm) combined with OSFE and standard dental implants (10mm) combined with OSFE for treating atrophic posterior maxilla of partially edentulous. 33 patients with 33 implants (Group 1: 9, Group 2: 12, Group 3: 12) were included in the present study. Implant survival rate, RFA measurements, operative time and patient satisfactory were evaluated. Comparison will be made among the 3 groups using ANOVA. The implant survival rates were 100% in all three groups. At implant placement, the mean ISQ values were 66.56 in group 1, 69.22 in group 2 and 70.78 in group 3. At implant impression, the mean ISQ values were 72.15 in group 1, 70.67 in group 2, and 71.78 in group 3. The operative time in group 1 (mean: 529.3±27.6) was significantly shorter than those in group 2 (mean 781.3±43.5) and group 3 (mean 820.8±54.1) (P<0.01). No significant difference of the intraoperative discomfort and postoperative pain scores was found among three groups. High survival rates, enough primary and secondary implant stability and excellent patient satisfactory can be achieved in all three groups. Short-6-mm implants group showed significantly shorter operative time. Future studies with large sample size should explore the difference of patient satisfactory among the three treatment strategies.

Keywords: short dental implants; osteotome sinus floor elevation; implant stability


Introduction

The posterior maxilla is commonly a great challenge for successful dental implant treatment due to the limited bone height and quality [1]. Thus, many efforts have been made to allow successful treatment in atrophic posterior maxilla, such as osteotome sinus floor elevation (OSFE), lateral sinus floor elevation, short implant, zygomatic implant and onlay bone graft [1-3]. Concerning moderate atrophic posterior maxilla (6mm≤RBH≤8mm), short dental implant and osteotome sinus floor elevation are considered as two optional choices.

Short dental implants are increasingly used in resorbed posterior area due to its simple surgical and prosthetic protocols. So far, the definitions of short dental implant vary in the literature. One highly accepted definition is that the designed intra-bony length is 8mm or less [4].

However, contradictory results are reported when short dental implants are inserted in moderate atrophic posterior maxilla. Our previous study has demonstrated that high survival rates can be achieved after 5-10years for Straumann short implants (6 or 8mm) in posterior region, without severe marginal bone loss and complications [5]. While another study reported significantly lower 10-year survival rates of Straumann short implants (6mm) were found in posterior
maxilla than those in posterior mandible [6].

On the other hand, OSFE described by Summers et al. (1994) has been proven to be a predictable surgical procedure to vertically increase the bone height in posterior maxilla with osteotomes with increasing diameters [7]. A previous systematic review has demonstrated that high implant success rate combined with OSFE technique can be achieved in moderate atrophic maxilla [8]. However, the addition OSFE procedure is a highly demanding technique, and may increase operative time, treatment cost and postoperative morbidity.

In addition, the combined application of short dental implants and OSFE procedures may be the third choices. Reduced postoperative morbidity and lower sinus membrane perforation rates may be the benefits of this option. However, limited studies have compared the clinical outcomes of the three treatment strategies in moderate atrophic posterior maxilla.

Up to now, most studies have focused on the implant clinical survival, marginal bone loss, biological and hardware complications. However, other factors, such as implant stability, operative time and patient satisfaction, also play an important role in developing the treatment strategies.

Thus, the aim of present study is to evaluate the implant stability, operative time and patient satisfaction of short dental implants (6mm) alone, short dental implants (8mm) combined with OSFE and standard dental implants (10mm) combined with OSFE for treating atrophic posterior maxilla of partially edentulous.

Material and Methods

Study design and patient data

The present study was designed as a prospective cohort study. Patient data were retrieved from an ongoing randomized controlled trial (NCT02350075). 33 patients who finished final restorations were divided into three groups:

Group 1: short-6-mm implant group;
Group 2: short-8-mm implant combined with OSFE group;
Group 3: standard-10-mm implant combined with OSFE group.

Surgery and prosthetic procedures

The detailed surgery and prosthetic procedures have been described in the published protocol [9]. For all cases, Straumann (Institute Straumann AG, Basel, Switzerland) Standard Plus implants were placed. In brief, the short-6-mm implants were inserted according to manufacturer's introduction. In Group 2, after implant site were prepared to the depth about 1-2mm away from the sinus floor, a modification of Summers' OSFE were performed to elevating the sinus membrane until the depth of 8mm. In Group 3, similar procedures were performed until the sinus membrane was elevated to the depth of 10mm. The Valsalva maneuver test was performed before implants placement. After a healing time of 3-4 months, single crowns were fabricated and deliver to the patients.

Outcome variables

Implant survival

Implant survival rate are defined by percentage of restorations that remained in situ.

RFA measurements

At implant installation as well as at implant impression, Resonance Frequency Analysis (RFA) measurements were conducted by the Osstell™ mentor (Integration Diagnostics AB, Goteborg, Sweden). For each individual implant, a standardized abutment was inserted and a transducer probe was held to display the implant stability quotient (ISQ) value. Three different directions (buccal, lingual and occlusal) were detected and a mean value of the three directions was applied for statistical analysis.

Operative time

Operative time was calculated from incision beginning to suture finishing.

Patient satisfaction

Patients was asked to give their answers regarding intraoperative discomfort and postoperative pain immediately and two weeks after surgery using a 100-mm visual analogue scale (VAS) with word descriptor "very dissatisfied" to "very satisfied" on the left and right respectively.

Statistical analysis

Data analysis was performed using a statistical software package STATA (version 11.0; StataCorp, College Station, TX, USA). The level of significance was set at α=0.05. The skewness and kurtosis test was used to test for normality of distribution of the data. Mean and standard deviation were calculated for quantitative variables. Comparison will be
Table 1. ISQ value of three groups (Mean±SD)

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n=9)</th>
<th>Group 2 (n=12)</th>
<th>Group 3 (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Implant Placement</td>
<td>66.56±3.24</td>
<td>69.22±2.34</td>
<td>70.78±2.19</td>
</tr>
<tr>
<td>At Implant Impression</td>
<td>72.15±1.75</td>
<td>70.67±1.52</td>
<td>71.78±1.26</td>
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Table 2. Operative time of three groups

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n=9)</th>
<th>Group 2 (n=12)</th>
<th>Group 3 (n=12)</th>
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<tbody>
<tr>
<td>1</td>
<td>626</td>
<td>568</td>
<td>752</td>
</tr>
<tr>
<td>2</td>
<td>359</td>
<td>900</td>
<td>858</td>
</tr>
<tr>
<td>3</td>
<td>603</td>
<td>895</td>
<td>502</td>
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<tr>
<td>4</td>
<td>508</td>
<td>1008</td>
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<td>5</td>
<td>488</td>
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<td>6</td>
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<td>9</td>
<td>512</td>
<td>778</td>
<td>685</td>
</tr>
<tr>
<td>10</td>
<td>665</td>
<td>576</td>
<td>978</td>
</tr>
<tr>
<td>11</td>
<td>642</td>
<td>976</td>
<td>896</td>
</tr>
<tr>
<td>Mean</td>
<td>529.3±27.6*</td>
<td>781.3±43.5*</td>
<td>820.8±54.1*</td>
</tr>
</tbody>
</table>

*, significant difference among three groups

Table 3. Patient satisfactory of three groups

<table>
<thead>
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<th>Group 1 (n=9)</th>
<th>Group 2 (n=12)</th>
<th>Group 3 (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative discomfort</td>
<td>9.58±0.15</td>
<td>9.50±0.23</td>
<td>9.02±0.21</td>
</tr>
<tr>
<td>postoperative pain</td>
<td>9.41±0.15</td>
<td>9.33±0.14</td>
<td>9.12±0.11</td>
</tr>
</tbody>
</table>

made among the 3 groups using ANOVA. Bonferroni test was performed to make the in situ comparison.

**Result**

**Implant survival rate**

33 patients with 33 implants (Group 1: 9, Group 2: 12, Group 3: 12) were included in the present study. No implant failure was found by the end of restorations placement. Thus, the implant survival rates were 100% in all three groups.

**RFA measurements**

The RFA measurements were performed on 33 implants. The mean implant stability quotient (ISQ) values obtained at implant placement and impression were present in Table 1. At implant placement, the ISQ values ranged from 44 to 75 (mean: 66.56±3.24) in group 1, from 56 to 79 (mean: 69.22±2.34) in group 2, and from 57 to 81 (mean: 70.78±2.19) in group 3. At implant impression, the ISQ values ranged from 64 to 80 (mean: 72.15±1.75) in group 1, ranged from 63 to 79 (mean: 70.67±1.52) in group 2, and ranged from 67 to 82 (mean: 71.78±1.26) in group 3. No significant difference was found among three groups both at implant placement and impression (P=0.67 and 0.88, respectively).

One patient showed relatively low ISQ value at implant placement in group 1: 44 at buccal site and 64 at lingual and occusal sites. After three months healing, the ISQ value increased to 61 at buccal site and 65 at lingual and occusal sites.

**Operative time**

The operative time ranged from 359 seconds to 626 seconds (mean 529.3±27.6) in group 1, from 455 seconds to 1008 seconds (mean 781.3±43.5) in group 2, and from 502 seconds to 1132 seconds (mean 820.8±54.1) in group 3. The ANOVA showed significant difference was found among three groups (P<0.01). The operative time in group 1 was significantly shorter than those in group 2 and group 3 (P<0.01).

**Patient satisfactory**

The intraoperative discomfort scores ranged from 9 to 10 (mean: 9.58±0.15) in group 1, from 9 to 10 (mean: 9.50±0.23) in group 2, and from 4 to 10 (mean: 9.02±0.21) in group 3 (Table 3). The postoperative pain scores ranged from 9 to 10 in all three groups (mean: 9.41±0.15 in group 1, 9.33±0.14 in group 2, 9.12±0.11 in group 3). No significant difference of the intraoperative discomfort and postoperative pain scores was found among three groups.

**Discussion**

The present study aimed to explore the most predictable treatment strategies in moderate atrophic posterior maxilla in
regard of implant stability, operative time and patient satisfaction.

In this study, 100% implant survival rates were achieved in all three groups at restorations insertion. This result demonstrated that early implant failure was scarce in all three groups. However, future studies should evaluate the short-term and long-term implant survival.

Two different concepts of implant stability, which named primary mechanical stability and secondary biological stability, were introduced. Primary implant stability is determined by the mechanical anchorage between implant and bone, while the secondary implant stability is determined by the biological contact between implant and bone and is called osseointegration \cite{10, 11}. In this study, relatively high ISQ values were found in all three groups both at implant placement and at implant impression. This indicated that enough primary and secondary implant stability could be achieved in all three groups. Senerby and Meredith (2008) suggested an ISQ of 55-65 to be a safe level of stability \cite{12}. One patient in group 1 showed relatively low ISQ value at buccal site at implant placement, and the ISQ value increase to 61 at implant impression. This may be explained by the resorbed bone at buccal site.

The ISQ values in short-6-mm group are similar to those in short-8-mm and standard-10-mm groups. This result is in line with previous study that the implant stability is not influenced by the implant length \cite{13, 14}. This might be explained by the “effective bone-to-implant surface” theory \cite{5, 15}. This indicated that short implants could achieved enough implant stability in moderate atrophic maxilla as well as the standard implants.

In this study, significantly shorter operative time in group 1 was found. The operative time was calculated from incision beginning to suture finishing, including the RFA measurements procedure. This indicated that the simplified surgical procedure in group 1 could significantly reduce the operative time. This agreed with previous results that short implant could simplify the surgical procedures, compared with standard implants combined with sinus floor elevation \cite{16, 17}.

Patient satisfaction, which was considered as one of the most important criteria for assessing the clinical success, was also assessed in this study \cite{18, 19}. In this study, visual analogue scale (VAS) was used to evaluate the intraoperative discomfort and postoperative pain. Excellent VAS values were found in all three groups (VAS: 4), while the postoperative pain was acceptable (VAS: 9). In view of the relatively small sample size included in the present study, the statistical power may not enough to detect the difference of patient satisfaction among three groups. Thus, future studies with large sample size should explore the difference of patient satisfaction among the three treatment strategies.

**Conclusion**

High survival rates, enough primary and secondary implant stability and excellent patient satisfaction can be achieved in all three groups. Short-6-mm implants group showed significantly shorter operative time. Future studies with large sample size should explore the difference of patient satisfaction among the three treatment strategies.

**Acknowledgments**

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**Conflicts of interest**

None declared.

**References**


9. Shi JY, Gu YX, Qiao SC, Zhang XM, Lai HC. Clinical evaluation of short 6-mm implants alone, short 8-mm implants combined with osteotome sinus floor elevation and standard 10-mm implants combined with osteotome sinus floor elevation in posterior maxillae: study protocol for a randomized controlled trial. Trials 2015; 16: 324.


