

COMPARISON OF THE DIFFERENT SURGICAL METHODS IN PATIENTS UNDERGOING IMPLANT RESTORATION WITH INSUFFICIENT RESIDUAL BONE HEIGHT IN THE POSTERIOR MAXILLARY REGION

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ABSTRACT

Objective: To explore different application values of maxillary sinus floor elevation and tilted implant placement in the treatment of patients undergoing implant restoration with insufficient residual bone height in the posterior maxillary region and provide more reference for the selection of clinical treatment regimes.

Methods: 168 teeth from 137 patients undergoing implant restoration with a residual bone height of less than 6mm in maxillary posterior region admitted to our hospital from January 2017 to March 2020 were included in this study. Among them, 80 teeth from 67 patients were treated with maxillary sinus floor elevation (Group A) and 88 teeth from 70 patients were treated with tilted implant placement (Group B). The cumulative implant survival rate, peri-implant marginal bone resorption and incidence of postoperative complications of 2 groups were compared.

Results: There was no significant difference between 2 groups in cumulative implant survival rate during the follow-up ($P > 0.05$). There was no significant difference between 2 groups in peri-implant marginal bone resorption after 12 months, 24 months and 36 months of follow-up ($P > 0.05$). There was no significant difference between 2 groups in the incidence of postoperative complications ($P > 0.05$).

Conclusion: Maxillary sinus floor elevation and tilted implant placement have similar overall efficacy and safety in the treatment of patients undergoing implant restoration with insufficient residual bone height in the posterior maxillary region.

Keywords: maxillary sinus floor elevation, tilted placement, maxilla, implantation.

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Introduction

The loss of maxillary posterior teeth can cause the resorption of alveolar ridge crest/maxillary sinus floor and negative pressure respiration and result in maxillary sinus pneumatization and residual bone mass deficiency⁽¹⁾. Patients with insufficient bone mass in the posterior maxillary region are generally treated with maxillary sinus floor elevation via alveolar ridge crest. However, due to the difficulty in direct vision operation, the height cannot be effectively lifted during the operation, and some of the sinus floors are prone to mucosal perforation⁽²⁾.

In recent years, implantation techniques become increasingly mature and popular, and new implantation methods represented by tilted implant placement have been used to treat patients with insufficient vertical bone in the posterior maxillary region⁽³⁾. It has been reported that tilted implant placement can partly avoid the occurrence of mucosal perforation and lower the complexity of bone augmentation, so as to increase the success rate of implant⁽⁴⁾. However, there's some skepticism about this viewpoint⁽⁵⁾. In light of this, 168 teeth from 137 patients undergoing implant restoration with a residual bone height of less than 6mm in maxillary

posterior region admitted to our hospital from January 2017 to March 2020 were included in this study, with a view to explore different application values of maxillary sinus floor elevation and tilted implant placement in the treatment of patients undergoing implant restoration with insufficient residual bone height in the posterior maxillary region and provide more reference for the selection of clinical treatment regimes.

Data and methods

General data

168 teeth from 137 patients under-going implant restoration with a residual bone height of less than 6mm in maxillary posterior region admitted to our hospital from January 2017 to March 2020 were included in this study. Among them, 80 teeth from 67 patients were treated with maxillary sinus floor elevation (Group A) and 88 teeth from 70 patients were treated with tilted implant placement (Group B). In Group A, there were 40 males and 27 females, aged 31~68, with an average age of (48.52±6.90). Implant type: there were 28 Dentium implants and 52 Straumann implants; restoration type: there were 32 cases restored with cement retained abutment supported crown or fixed bridge, and 35 cases restored with screwretained or cementretained single crown. In Group B, there were 42 males and 28 females, aged 32~66, with an average age of (48.99±7.12).

Implant type: there were 40 Dentium implants and 48 Straumann implants; restoration type: there were 33 cases restored with cement-retained abutment-supported crown or fixed bridge and 37 cases restored with screwretained or cement-retained single crown. The study protocol complied with the Declaration of Helsinki, and the patients and their families signed in-formed consent.

Inclusion and exclusion criteria

Inclusion criteria: a tooth in the posterior maxillary region was lost and; the residual bone height was less than 6mm; completed implant restoration successfully and the gingival distance was appropriate; the tilt angle of implant was between 25 and 35 ; with complete clinical data.

Exclusion criteria: night bruxism; gnashing; severe endocrine diseases; received maxillary

radiotherapy before; complicated with other diseases that may influence implant restoration.

Treatment methods

All surgical regiments were drawn up and operated by the same group of doctors. Before surgery, panoramic tomography or conebeam CT examinations were completed. The adjacent teeth or intraoral marks were taken as gauge points, and the tilt angle and direction of implants were clearly explained. Before surgery, chlorhexidine gargle was adopted to rinse the mouth, and the opening and flap surgery of the posterior maxillary region was completed under local anesthesia. The implant site and direction were determined, according to imaging data, alveolar bone morphology during surgery and abutment relationship with adjacent teeth, and then an implant socket was established. After the integrity of maxillary sinus mucosa was evaluated and confirmed, the implant was inserted and tightly sutured. Group A was treated with conventional maxillary sinus floor elevation via alveolar ridge crest, while Group B was treated with tilted implant placement. According to the preoperative design, the implant was tilted towards the mesial or distal side along the maxillary sinus wall, or inserted through the palatal side, at a tilt angle between 25 to 35 . On the same day after the surgery, panoramic tomography or cone-beam CT examinations were completed, the positional relationship between the implant and the maxillary sinus floor and the tilt angle of implant were assessed. 3 days after surgery, routine anti-infection was administered, 7 days after surgery, routine chlorhexidine gargle was administered, and 3 months after surgery, the integration between implant and bone was checked. Fixed denture restoration was administered, after making sure that the integration was good.

Observed indicators

All patients included were followed up for 12 months or more, the median follow-up period was 20.0 (13.0~39.0) months. The implant survival was rec-orded, and the evaluation criteria were: the implant was stable, no X-ray trans-mission was found around the implant⁽⁶⁾. After 12 months of follow-up, the vertical bone resorption was less than 0.2mm, there was no pain, infection or other discomfort, the prosthesis was aesthetic and the patients' satisfaction

was high. The peri-implant marginal bone resorption was determined by the data of pan-oral tomography and cone-beam CT. Digimizer Image Analysis Software was used to measure the changes in peri-implant marginal bone mass, that is, the vertical length from the contact point between the mesial and distal sides of the implant and the crest of bone tissues to the plane of implant neck. The measurement was repeated for 3 times and the average was taken. The incidence of postoperative complications was evaluated according to the results of oral examination.

Statistical processing

SPSS20.0 software was selected to process data. The measurement data were compared using a t-test and repeated measures ANOVA and expressed by (\pm s). The enumeration data were compared using a χ^2 test and expressed by %. The cumulative implant survival rate was analyzed using Kaplan-Meier curve. $P < 0.05$ indicated statistically significant.

Results

Comparison between 2 groups in terms of cumulative implant survival rate

The cumulative implant survival rates in Groups A and B in the last follow-up were 98.51% (66/67) and 100.00% (70/70), respectively; there was no significant difference between 2 groups in cumulative implant survival rate during the follow-up ($P > 0.05$).

Comparison between 2 groups in terms of periimplant marginal bone resorption

There was no significant difference between 2 groups in periimplant marginal bone resorption after 12 months, 24 months and 36 months of follow-up ($P > 0.05$). See Table 1.

Group	Number of Teeth	1 Year After Surgery	2 Years After Surgery	3 Years After Surgery
Group A	80	0.59±0.21	0.85±0.30	0.93±0.37
Group B	88	0.56±0.20	0.82±0.28	0.90±0.34

Table 1: Comparison between 2 Groups in Terms of Peri-implant Marginal Bone Resorption (mm).

Comparison between 2 groups in terms of incidence of postoperative complications

After surgery, there was no obvious complication in Group A, but there were 2 cases of food impaction and 1 case of loose screw in the fixed

bridge of the posterior maxillary region. All of these conditions were improved after treatment. There was no significant difference between 2 groups in the incidence of postoperative complications ($P > 0.05$).

Discussion

Previous studies showed that up to 45%~75% patients with a lost tooth in the maxillary molar region had a residual bone height of less than 5mm⁽⁷⁾. Tilted implant placement was superior to the traditional surgical method in improving the utilization rate of original bone mass. It can shorten the operation time and prevent mucosal perforation by bypassing the existing areas with insufficient bone mass and avoiding the complex operation of bone augmentation⁽⁸⁾. Other studies also reported that tilted implant placement allowed longer implants to be inserted and enlarged the bonded area between the implant and the bone, thereby improving the implant success rate⁽⁹⁾.

A meta analysis verified that tilted implants didn't increase the failure rate of implant restoration and or the degree of bone resorption, and the long-term survival rate was $>95\%$ ⁽¹⁰⁾. According to the results of this study, the cumulative implant survival rates in Groups A and B in the last follow-up were 98.51% (66/67) and 100.00% (70/70), respectively; there was no significant difference between 2 groups in cumulative implant survival rate during the follow-up ($P > 0.05$), which was similar to the results reported above. The cause of 1 failure in Group A: the patient's posterior maxillary region was severely osteoporotic, and the osseointegration around the implant was incomplete after elevation, making the implant fall off. Previous studies contended that tilted implant placement can significantly improve the initial stability of implant by directly bonding with the bone⁽¹¹⁾. The results of our study, however, didn't support this viewpoint. The author guessed that this was probably related to the insufficient sample size and selection bias.

The key to ensuring the long-term survival of an implant is to maintain the stress level of the implant neck within reasonable limits. It is currently believed that the force-bearing point of a tilted implant is mainly located at the edge of implant neck, and this force is positively correlated with the tilt angle⁽¹²⁾. On the other hand, the insertion direction of implant must be perpendicular to the bone surface of alveolar ridge, so as to ensure long-term survival⁽¹³⁾. A 36-month follow-up study suggested that tilted or axial implants wouldn't exert a marked influence on

the loss of peri-implant marginal bone⁽¹⁴⁾. According to the results of this study, there was no significant difference between 2 groups in peri-implant marginal bone resorption after 12 months, 24 months and 36 months of follow-up ($P>0.05$), which also confirmed this viewpoint, that is, peri-implant marginal bone wouldn't be lost as long as the tilt angle of implant was kept within reasonable limits. Some scholars held that fixed bridge restoration can be employed to obtain satisfactory results when the tilt angle of implant was less than 25° or the implant was inserted obliquely in a fall-en-8-shape. It should be noted that when the tilt angle is greater than 30°, the local stress increases significantly, so it is presumed that the tilt angle of implant should be within 30°^(15,16). In this study, the tilt angle of implant of patients in Group B was between 25 and 35°. Theoretically, the restoration of the edentulous region through abutment-supported crown or fixed bridge can effectively lower bone stress at the edge of implant neck and ensure the long-term survival of implant. On the basis of the above evidence, the author suggests that if single-crown restoration is applied in the tilted implant placement, the tilt angle of implant should be kept within 30°.

There are also some shortcomings in this study: the sample size included is insufficient, and this study is a single-center retrospective report, so the risk of selection bias cannot be completely rule out from the results; The follow-up time is short, which makes it difficult to evaluate the long-term efficacy accurately, and the conclusion is yet to be confirmed by subsequent studies.

To sum up, maxillary sinus floor elevation and tilted implant placement have similar overall efficacy and safety in the treatment of patients undergoing implant restoration with insufficient residual bone height in the posterior maxillary region.

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