

Research Progress on Titanium Implants for External Maxillary Sinus Augmentation

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Abstract: In patients with missing maxillary posterior teeth, the negative pressure generated by breathing leads to an increase in the gasification of the maxillary sinus cavity, as well as the absorption of alveolar bone due to the lack of physiological stimulation due to missing teeth. This often leads to insufficient bone height during implant restoration in the maxillary posterior tooth area, and maxillary sinus floor elevation surgery can effectively solve this problem. At present, there are two main techniques for lifting the maxillary sinus floor: internal lifting through the top of the alveolar ridge approach and external lifting through the lateral wall approach. Among them, the maxillary sinus alveolar ridge lifting surgery is widely used due to its advantages of small wound size, short surgical time, fewer postoperative complications, low cost, and easy acceptance by patients. With technological innovation, the indications for maxillary sinus floor elevation surgery have gradually expanded to cases with residual bone height (RBH) greater than 2 mm.

Keywords: Titanium implants, Titanium implant.

1. Introduction

After research, it was found that a root tip examination was performed 3 months after implantation to measure the stability of the implant. If the imaging examination showed no obvious low-density shadows around the implant and the implant had good stability, upper repair should be performed. After 12 months of repair, follow-up visits were conducted for clinical examination, root tip films were taken, and the patient's age, gender, implant position, implant bone union, implant edge bone absorption, maxillary sinus bone formation, and soft tissue around the implant were observed and recorded.

1.1. Marginal bone resorption

On the day of initial diagnosis and final restoration, and at each follow-up, parallel projection techniques were used to take apical films around the implant. The root tip film was taken by experienced technicians using standardized X-ray film, film holder, and parallel projection technology (XCP Instruments, Rinn Corporation Elgin, Elgin, IL, USA). The reference materials for internal calibration are implant length and thread distance. By using computer software (Image J, National Institutes of Health, Maryland, USA), the distance between the edge of the restoration and the coronal level of the surrounding bone junction was recorded, and the final result was the average value of the proximal and distal parts. The change in distance between baseline and follow-up is defined as marginal bone resorption. If there is a difference of 0.5 mm in the measurement results between two physicians, re measure. [5]

1.2. Osteogenesis of maxillary sinus

After surgery and at each follow-up, parallel projection technology was used to take apical films around the implant, and the length of the implant was used as a calibration reference to record the distance from the edge of the maxillary sinus to the root tip of the implant. The data were measured by two physicians using the same method as the root tip film. The change in distance between baseline and follow-up is

defined as the amount of maxillary sinus bone formation. [6]

1.3. Mechanical complications

During the follow-up period, mechanical complications such as porcelain tightening of the restoration, breakage of the abutment or implant, and loosening or breaking of screws were recorded.

1.4. Soft tissue condition around the implant

The evaluation indicators for soft tissue conditions around implants include probing depth (PD), bleeding on probing (BOP), and modified plaque index (mPI). The exploration tool is a periodontal probe (UNC-15; Hu Friedy, Chicago, USA). All indicators are recorded on the final repair day and at each follow-up.

The distance between the top of the alveolar ridge and the bottom of the maxillary sinus is called the sinus crest distance. When the initial bone height at the implant site is insufficient and it is not allowed to implant the desired length of the implant, the use of maxillary sinus floor elevation surgery can increase the bone height. Studies have shown that the technique of lifting the maxillary sinus by penetrating the crest of the alveolar ridge or opening the lateral wall can increase the available bone mass at the implant site and achieve satisfactory clinical results [1-3]. According to whether to perform implant implantation simultaneously with maxillary sinus elevation, it can be divided into synchronous and delayed implant implantation. According to Volume 5 of the ITI Guidelines, it is recommended to perform maxillary sinus lateral wall window lifting surgery simultaneously with implant implantation when the remaining alveolar bone height is 3-6mm. When the RBH is less than 3mm, delayed implant implantation is performed [4]. Smiler [5] divided the surgical procedures into three types: grinding, flipping, and uncovering. The surgical method used in this study was the third, with no implant failure and a 100% implant retention rate. The remaining vertical bone mass in this study was (4.17 ± 0.86) mm, with the smallest being 2.57mm and the largest being 5.68mm. All patients who underwent external augmentation underwent Bio oss bone powder implantation

at the same time, And a 10mm long implant was implanted simultaneously. In recent years, there have been varying opinions in the academic community on whether to implant bone filling materials after maxillary sinus elevation. Some scholars have pointed out that implanted bone filling materials can delay the regeneration process of bone tissue around the implant compared to autologous bone [6].

A series of biomimetic coatings containing strontium titanate micro nano structures with different grades were prepared on the surface of titanium implants through thermal alkali treatment and magnetron sputtering technology. The results of scanning electron microscopy, energy dispersive spectroscopy, water contact angle, X-ray diffraction, atomic force microscopy, etc. indicate that the titanium implant containing strontium titanate micro nano biomimetic structure coating has been successfully constructed. Among them, the AH-Ti/Sr90 group has the best bone differentiation promoting function, which can promote osteoporosis and normal bone bonding of implants, and can be used as the optimal coating preparation parameter for subsequent experiments. 2. Successfully prepared titanium implant surface locking/silver micro nano biomimetic coating, which has bone promoting and antibacterial functions. Construct a micro nano biomimetic coating containing strontium/silver on the surface of titanium implants using hot alkali treatment and magnetron sputtering technology. The results of scanning electron microscopy, X-ray energy spectrometer analysis, X-ray photoelectron spectroscopy detection, water contact angle detection, ion release experiment, etc. indicate that the titanium implant coated with silver/silver micro nano biomimetic structure has been successfully constructed. The results of in vitro cell experiments showed that the AH-Ti/Ag group exhibited significant cytotoxicity, and both the AH-Ti/Ag/Sr and AH-Ti/Sr groups exhibited good cell morphology and proliferative activity, The AH Ti/Ag/Sr group exhibited better cell activity and cell spreading area compared to the AH Ti/Ag group. The results of in vivo animal experiments showed that more new bone formation was observed in the AH Ti/Ag/Sr group and AH Ti/Sr group. The antibacterial experiment results indicate that the AH Ti/Ag and AH Ti/Ag/Sr groups have significant antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*. Compared to the AH Ti/Ag/Sr group, the antibacterial activity of AH Ti/Ag is stronger.

2. Conclusion

This study utilizes hot alkali treatment and magnetron emission technology to construct titanium containing materials with different grades on the surface of titanium materials. Titanium implant coated with strontium acid micro nano biomimetic structure has been demonstrated through in vitro and in vivo experiments at 80W, with a delivery rate of 90%. The coating (AH Ti/Sr90) prepared under the parameters of minutes has the best bone promoting performance. In this study, building on the foundation of Preparation of Titanium Seeds with Strontium/Silver Micro Nano Biomimetic Structure (AH Ti/Ag/Sr) Coating by Stepwise Modification, the implant has been proven to have good biocompatibility through in vitro and in vivo osteogenesis experiments as well as antibacterial experiments. Sex, promoting osteogenic differentiation ability, and good antibacterial activity, and AH-Ti/Ag/Sr can be slowly released in moderation. Release silver ions and strontium ions to synergistically promote bone resorption. This study focuses on the surface junctions of dual coatings.

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