Minimally Invasive Crestal Sinus Lift Technique and Simultaneous Implant Placement

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Objective: *To evaluate the effectiveness and clinical results of a new crestal sinus lift technique used to elevate the sinus floor simultaneously with bone grafts and implant placement.*
Methods: *Eleven patients underwent this crestal sinus lift technique performed using an SCA KIT. The mean residual bone height was 6.4 mm (range: 4.1 mm to 8.6 mm). Bio-Oss collagen was used as the graft material, and 12 implants were simultaneously placed after sinus augmentation. Radiographic and clinical examinations were conducted during follow-up.*
Results: *All procedures were successfully performed with no obvious Schneiderian membrane perforation. The sinus floor was augmented with a mean height of 4.8 mm (range: 2.8 to 7.4 mm). Twelve implants healed uneventfully with healing abutments. Peri-implant marginal bone was stable, with a mean follow-up of 49.4 months (range: 33 to 71 months). No complications were observed during follow-up.*
Conclusion: *According to the limited data collected in this study, the novel crestal sinus lift approach could effectively lift the sinus floor and reduce the incidence of postoperative complications. Additional cases with long-term follow-up are needed to confirm and improve this crestal sinus lift technique.*
Key words: *bone graft, bone regeneration, dental implant, minimally invasive, osteotome, sinus lift*
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Deficient crestal bone is a common issue encountered in edentulous posterior maxillae owing to atrophy of the alveolar bone and maxillary sinus pneumatisation[1]. During recent decades, numerous studies have reported this issue, and many surgical techniques, as well as grafting materials used for maxillary sinus augmentation, have been evaluated[2,3]. Sinus augmentation with lateral access has been widely studied and is considered safe, with highly predictable outcomes[4-9]. The sinus grafting procedure with the lateral approach is often recommended to provide sufficient support for implants placed in extremely atrophic maxillary posterior ridges.

However, in cases where bone volume needs to be increased in order to regenerate bone for implant placement in a more conservative, less invasive and simpler manner, the crestal approach is preferred over the lateral approach. In 1994, Summers proposed the osteotome technique[10]. Afterwards, to perform maxillary sinus floor augmentation minimally, certain authors proposed modifications to the Summers' technique, essentially based on use of different bone grafts or novel instruments, as well as expansion and compression of the alveolar crest[11-17]. In addition, crestal approaches were demonstrated to be safe with highly predictable outcomes when the residual bone height was ≥ 5 mm[18].

In sinus augmentation procedures, different graft materials mixed with or without autologous bone have

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been frequently used[19-21]. Autogenous bone grafts are considered the gold standard owing to their maintenance of cellular viability and osteogenic capacity. Boyne and James[22] and Tatum[23] first reported the use of autogenous grafts in sinus floor elevation. In order to reduce the volume of autogenous bone to be harvested and the morbidity of the donor area, bone substitutes are used in sinus augmentation. Tricalcium phosphate was the first bone substitute to be successfully applied for sinus floor elevation[23].

Over the years, allografts, alloplasts, and xenografts of various types have been used alone, or in combination with autografts. These grafting materials were reported with potential for osteogenesis, osteoconduction or osteoinduction[24]. Nevertheless, the necessity of a grafting material to maintain the space for new bone formation after elevating the sinus membrane by using the crestal approach remains controversial[25]. However, use of graft materials may certainly improve bone formation around implants[26].

The primary complications of the transalveolar technique include perforation of the sinus membrane, bleeding, and graft bone resorption[27]. In order to minimise the risk of Schneiderian membrane perforation, several novel instruments designed specifically for sinus membrane lifting have been proposed[12,14,28-30]. In the present study, a modified crestal approach was used to simultaneously elevate the sinus floor and insert an implant. The shape of the drill tip was designed to prevent perforation of the sinus membrane and permit gentle abrasive removal of the cortical bone of the sinus floor without perforation of the sinus membrane. The objective of this study was to evaluate the effectiveness and clinical results of this technique.

Fig 1 A preoperative radiograph was recorded and the residual bone height of the missing left first molar was measured.

Materials and methods

Eleven patients (five women and six men) were consecutively treated with implants that were simultaneously inserted after sinus augmentations by using a new crestal approach (SCA KIT, Neobiotech, South Korea) at the Department of Implant Dentistry, Peking University School of Stomatology. The indication for sinus floor elevation was that the residual bone height was > 4 mm and < 9 mm. All patients were treated between July 2010 and September 2013. Panoramic radiography or cone beam computed tomography (CBCT) was used for evaluation of bone volume and sinus lesion at the primary examination (Fig 1). Before surgery, all oral diseases were thoroughly treated. The systemic and local conditions were comparable with implant placement and the sinus floor elevation procedure. The Institutional Review Board, Peking University School of Stomatology, approved the research protocol and all patients received a thorough explanation regarding the treatment plan and signed an informed consent form.

Panoramic examination was performed straight after surgery as baseline and periapical radiograph or panoramic examination was conducted at the time of prosthesis delivery, as well as approximately 1 year after loading. The marginal bone level was assessed at mesial and distal implant surfaces by measuring the distance

Fig 2 The marginal bone level was assessed by measuring the distance between points a and b. Point "a" was the intersection of marginal bone and implant surface and point "b" was the implant-abutment interface.

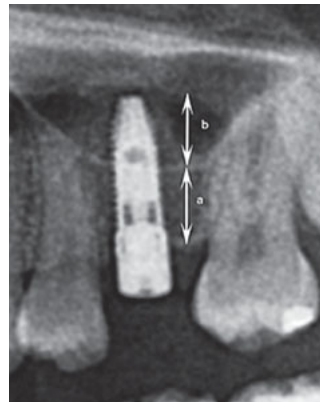

Fig 3 A scheme depicting "a" as the residual bone height and "b" as the elevation height immediately after surgery.

between the intersection of marginal bone and implant surface (a point) and the point of implant–abutment interface (b point) and calculating the average. The marginal bone resorption level was determined as the difference between the marginal bone levels at baseline and at 1 year after loading (Fig 2).

In order to measure the amount of sinus floor elevation, the distance from the implant tip to the intersection of sinus floor and implant body was measured in postoperative panoramic radiographs (Fig 3). The Planmeca Romexis 2.3.0.R software (Planmeca, Helsinki, Finland) was used with an accuracy of 0.1 mm. Magnification was calculated by measurement of known length of the implants.

Surgical procedures

All surgical procedures were conducted under local anaesthesia by using articaine hydrochloride with 1:100,000 adrenalin (Merignac Cedex, Merignac, France). A crestal incision was performed without a vertical releasing incision. A full-thickness mucoperiosteal flap was reflected not exceeding the alveolar ridge. A 2.0 mm diameter round bur was used to grind the alveolar cortical bone. Subsequently, a 2.0 mm diameter pilot drill followed by a 2.8 mm diameter drill was used to prepare the implant site, reaching approximately 2.0 mm short of the sinus floor. The sinus floor was lifted with the Ø 2.8 mm S-Reamer drill, and the stoppers were changed step by step to elevate the sinus membrane by approximately 1.0 mm each time until the desired elevation was reached (SCA KIT, Neobiotech). Sinus membrane perforation was checked using the Valsava manoeuvre. Subsequently, Bio-Oss Collagen (Geistlich Pharma AG, Wolhusen, Switzerland) was inserted into the space and implants were placed simultaneously. The healing abutments were connected if the insertion torque exceeded 35 Ncm (Figs 4 to 10). The scheme showed this modified minimally invasive technique could elevate the sinus floor safely by using specially designed S-reamer drills (Fig 11). The flap was repositioned and sutured using 4-0 absorbable sutures. Postoperative CBCT showed the sinus floor was lifted evenly right after the operation (Fig 12).

Postoperative care

Patients were discharged with a single 600 mg dose of ibuprofen (SKF, Tianjin, China) for analgesia and cefuroxime axetil tablets (CCPC, Suzhou, China) 0.25 g to be taken for 7 days for prophylaxis.

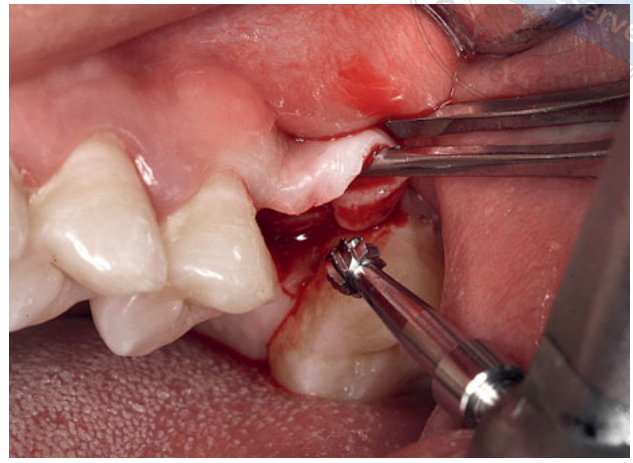

Fig 4 A 2.0 mm diameter round bur was used to set the implant insertion point.

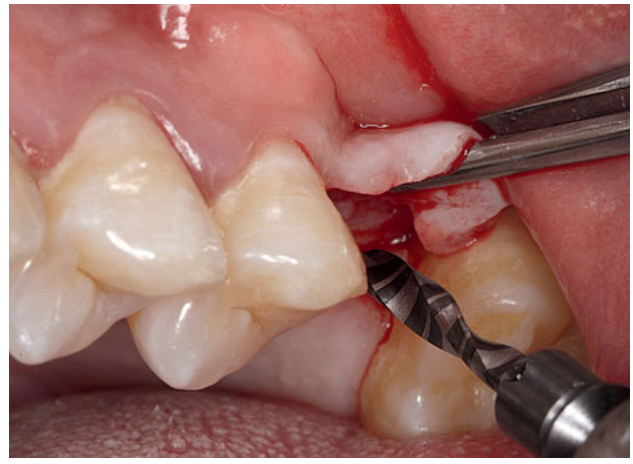

Fig 5 A 2.0 mm diameter pilot drill was used to prepare the implant site 1.0 mm shorter than the residual bone height until the final drill.

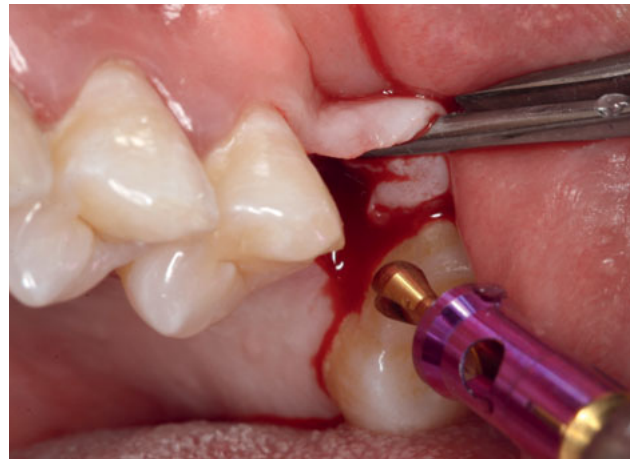

Fig 6 Specially designed S-reamer drills were used to grind the inferior cortical bone without sinus membrane perforation.

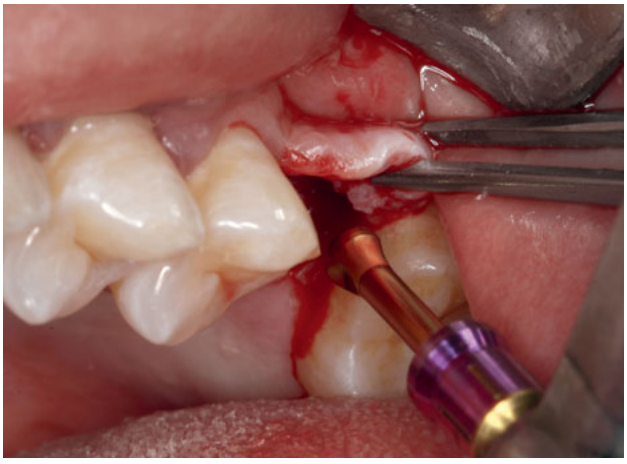

Fig 7 Stoppers mounted on S-reamer drill could control the drilling depth.

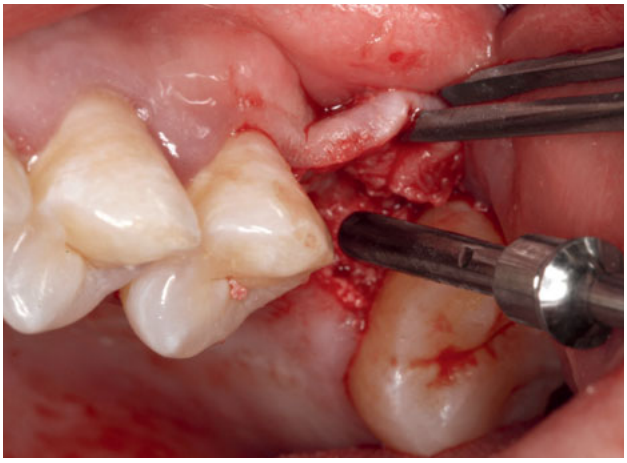

Fig 8 Bone condenser mounted with appropriate stopper was used to keep the bone graft material in place under the sinus floor.

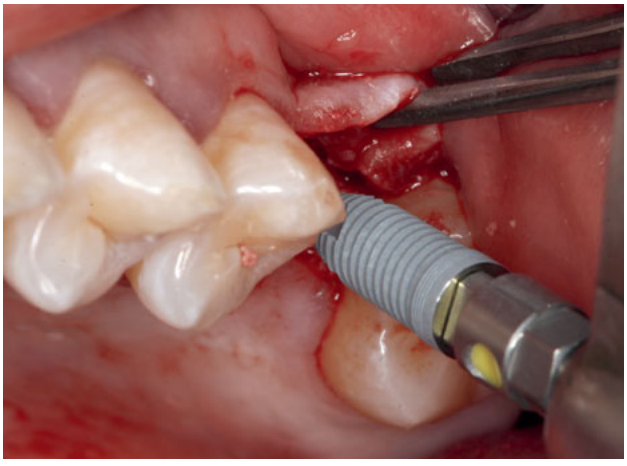

Fig 9 Implant placement at the prepared site.

Prosthetic procedure

After approximately 6 months of healing, zirconia-based, all-ceramic crowns (Procera, Nobel Biocare, Goteborg, Sweden) were delivered.

Follow-up

Postoperative patient reactions, including swelling, discolouration, discomfort, haematomas and disability, were recorded and surgical complications, which included severe bleeding, wound and/or sinus infection, flap dehiscence and implant failure, were documented after surgery. After the permanent prostheses were delivered, peri-implantitis, porcelain fracture, abutment screw loosening, abutment screw fracture, implant loosening and implant fracture were documented during follow-up.

Results

Use of the SCA KIT could effectively lift the sinus floor membrane. All procedures were successfully performed with no obvious Schneiderian membrane perforation (Fig 13). The mean residual bone height was 6.4 mm (range: 4.1 to 8.6 mm), and the mean elevation height was 4.8 mm (range: 2.8 to7.4 mm). Overall, 12 implants (Nobel Biocare) were simultaneously placed. Postoperative periapical radiographs after 6 months showed a stable bone graft. The mean marginal bone loss was 0.61 ± 0.09 mm at 1 year after loading (Fig 14). No implant was lost during follow-up. The mean follow-up period was 49.4 months (range: 33 to 71 months). Postoperative patient reactions were mild and no complications were observed during the entire treatment period and follow-up.

Discussion

Insufficient bone volume is a major concern in implant rehabilitation of posterior atrophic maxillae. Various techniques using different instruments have been proposed for sinus floor elevation, including lateral and crestal approaches. A recently published systematic review concluded that use of either the lateral approach or the osteotome technique for increasing bone volume is effective, particularly based on the available residual bone[31]. In the present study, the mean residual bone height was 6.4 mm (range: 4.1 to 8.6 mm). Sinus floor elevation was successfully performed through a crestal approach by using a SCA KIT combined with Bio-Oss

Collagen. Among these cases, 10 patients with a single missing tooth were treated using this technique for sinus floor elevation. Only one case received insertion of two implants; however, the increasing elevation height of this case was just 2.8 mm. Thus, additional studies are warranted to confirm whether this technique is suitable for cases with multiple missing teeth. According to the limited data available in the study, this new technique can be used to elevate the sinus floor effectively and atraumatically.

With the goals of simplifying surgical procedures, increasing survival rates of dental implants, and reducing complications, several new techniques, including air-filled balloons, sonic instruments, tapping drills and hydraulic pressure, have been reported with successful outcomes[6,16,17,32-34]. However, a recent literature review concluded that these techniques do not significantly reduce the incidence of sinus membrane

Fig 10 Healing abutment was connected if the insertion torque exceeded 35 Ncm.

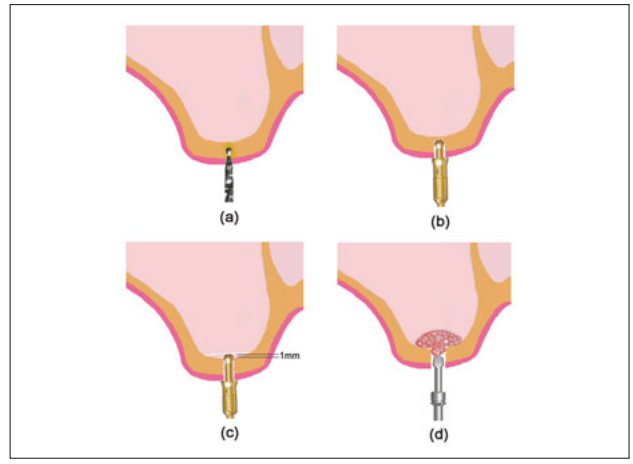

Fig 11 **a)** A 2.0-mm-diameter pilot drill was used to prepare the implant site floor approximately 2.0 mm under the sinus; **b)** An S-reamer drill was used to grind the sinus inferior cortical bone; **c)** The stoppers were changed step by step to elevate the sinus membrane by approximately 1.0 mm each time until reaching the desired elevation; **d)** A bone spreader was used to place bone graft into the subantral space.

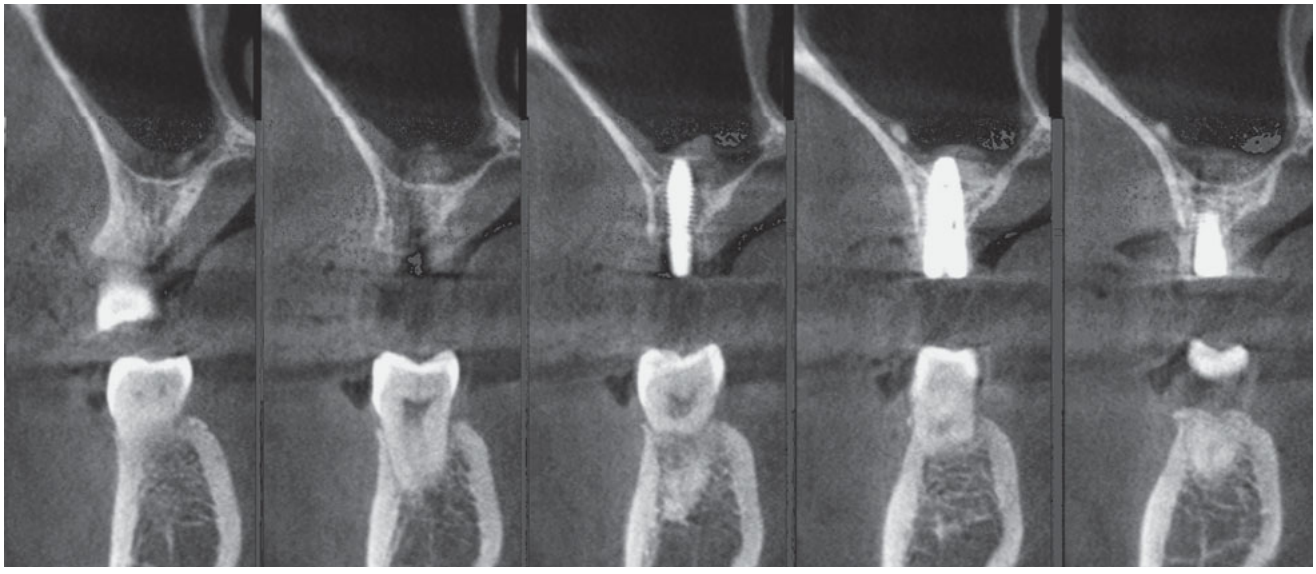

Fig 12 CBCT revealed even elevation of the sinus floor immediately after surgery.

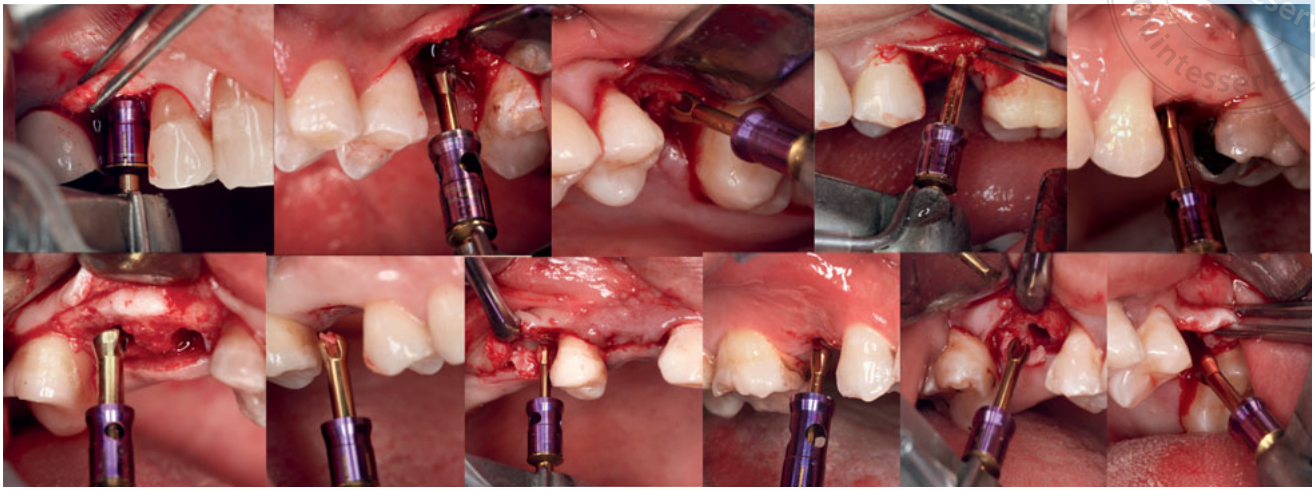

Fig 13 Clinical photographs showed the sinus floor was lifted using these S-reamer drills. Stoppers mounted on the S-reamer drills prevented sinus membrane perforation.

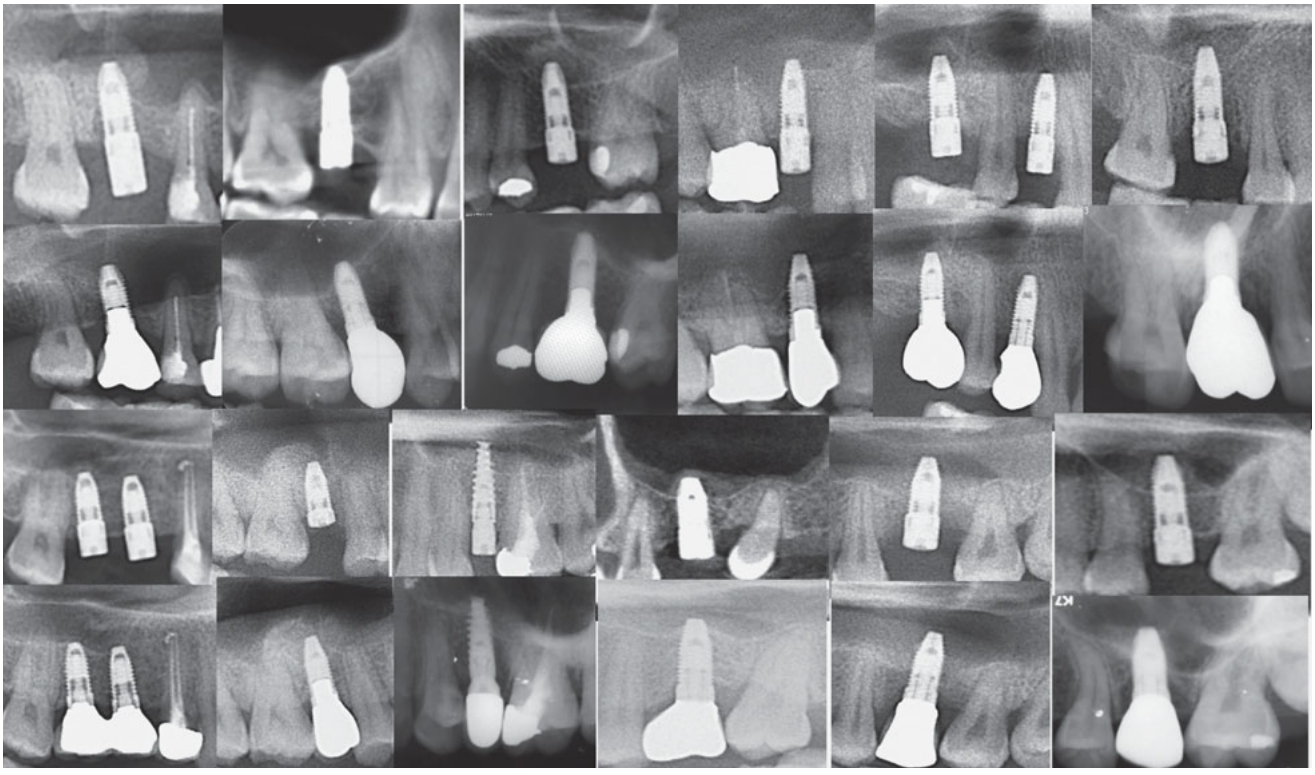

Fig 14 Postoperative periapical radiographs after 6 months showed a stable bone graft. With a mean follow-up period of 49.4 months (range: 33 to 71 months), periapical radiographs showed stable peri-implant marginal bone growth after permanent prostheses delivery.

perforation, which is the most frequent intraoperative complication[35]. This case series demonstrates several advantages of the presented technique with specially designed tools. It offers relatively less invasive surgery and a lower rate of sinus membrane perforation. With specially designed blades, the tools can exactly reach the subcortical bone with smooth grinding. Stoppers mounted on the S-reamers with different lengths enable safe and quick drilling with adequate control over the drilling depth. Moreover, stoppers can be mounted on the bone condenser to ensure accurate lifting height. Acting as a buffer tool, the bone condenser was used to

insert grafting materials under the sinus floor. Due to the smaller size of the prepared implant site compared with the diameter of the implant, this guaranteed the primary stability of the inserted implant. Results revealed an ideal sinus elevation height without membrane rupture. Furthermore, patients did not experience any osteotome hammering during the surgical procedure. However, when using the osteotome hammering technique, the autologous bone left in the sinus floor might be helpful for later bone formation compared with the current technique.

Nevertheless, the need to use grafting materials for sinus augmentation remains unclear. Previous studies have reported high survival rates when osteotome sinus floor elevation was used with grafting[18,36-37]. Subsequently, a systematic review also reported a high implant survival rate (> 96% after 5 years) even without grafting materials, through an osteotome-mediated approach in the posterior maxilla[38]. Chen et al found that the survival rates of dental implants after sinus floor elevation through the osteotome technique did not differ significantly with or without grafting materials[39]. In the present technique, Bio-Oss Collagen was used to maintain grafting materials in the space below the sinus membrane. Results showed good primary stability of dental implants, and the mean sinus floor elevation height with Bio-Oss Collagen was 4.8 mm (range: 2.8 to 7.4 mm). Another consideration of using Bio-Oss Collagen was that the collagen component could keep the bone graft from any displacement. Moreover, with antibacterial properties, it could reduce the risk of infective complications caused by small sinus membrane perforation. Thus, this crestal sinus lift technique provided a much safer and more reliable sinus floor elevation.

Conclusion

The crestal sinus lift technique performed using the SCA KIT is a minimally invasive procedure with sufficient bone gain and a high survival rate of dental implants. Common complications of maxillary sinus augmentation, such as membrane perforation, graft loss and severe infection, did not occur during follow-up. Nevertheless, additional cases with long-term follow-up are warranted to confirm and improve this crestal sinus lift technique.

Conflicts of interest

The authors reported no conflicts of interest related to this study.

Author contribution

Dr Xian ZHOU collected the data, recorded the follow-ups and wrote the paper; Dr Xiu Lian HU designed the study, completed the surgical and oral restoration procedures; Dr Jian Hui LI designed the restoration process; Prof Ye LIN designed the surgical procedures.

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