Sinus elevation with short implant

Authors: Prof. Dr Mauro Marincola, Prof. Dr Dr Rolf Ewers, Prof. Giorgio Lombardo (University of Verona) & Prof. Miguel Simancas Pallares (University of Cartagena), Austria/Italy/Colombia

Introduction

An upper posterior edentulous maxilla with diminished bone height usually represents a challenging situation for clinicians when dental implantation is the solution for tooth absence. Bone decrease is the result of a reduction in both height and width of the alveolar process due to the maxillary sinus pneumatisation.[1]

Two main options have been proposed to lift the Schneiderian membrane and then create some space to place implants: the lateral approach that increases treatment-related costs, postoperative morbidity and also surgical time, and the osteotome sinus floor elevation (OSFE) firstly introduced in 1986 by Tatum. Then in 1994 Summers introduced the maxillary sinus lifting internal sinus lift (ISL) technique by the use of osteotomes, in which bone is added to the apical part of the implant to improve implant primary stability.[2,3] This technique was shown to be less invasive, less time consuming and reduces postoperative discomfort to the patient.

Fig. 1: Pre-operative patient assessment: X-ray of the edentulous space showing maxillary sinus pneumatisation.

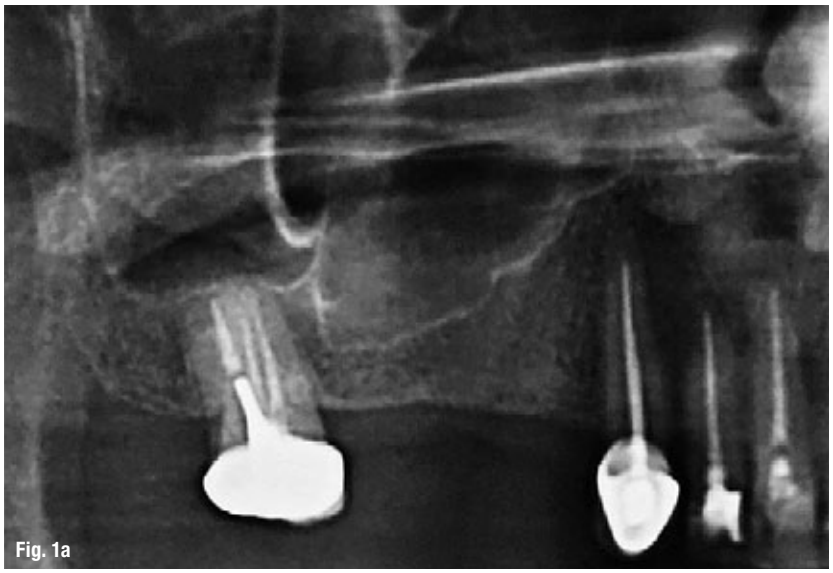

Fig. 1a

ISL is indicated when residual bone height (RBH) is between 5 and 7 mm. Other authors perform ISL in RBH extreme conditions such as ≤ 4 mm.[4]

There's an increasing debate whether a bone graft is needed into the elevated area to maintain the space for new bone formation in the future. According to Summers' original report, autogenous, allogenic or xenogeneic grafting materials are often placed.[5] Recently Nedir et al. showed no differences ($P > 0.05$) between ISL procedures performed with or without bone graft on the apical portion.[6] However, the main clinical challenge arises when a bone graft is placed and the bone around the implant-abutment interface needs to be maintained.

Rammelsberg et al. performed ISL but without bone graft in a retrospective study in 66 patients with 101 dental implants in 2015. By using X-rays, they determined bone changes over the time.[7] They further obtained results that mesial and distal mean apical bone gain (initial-final bone height) were 0.5 mm and 0.4 mm respectively, thus recommending that implants placed in combination with ISL without graft material would have bone gain.

Likewise, Nedir et al. compared dental implants plus ISL placed in combination with and without bone graft in 2013. They concluded that, although more bone is observed when the grafting material is used (5 mm) in comparison with non-grafted sites (3 mm, $P < 0.05$), this may not be required to promote endo-sinus gain.

Although there's no consensus whether bone graft should be placed via ISL procedure or not, this option is highly recommended due to the benefits regarding osseous level maintenance. The aim of this study was to describe radiographic parameters of minimally-invasive internal sinus elevation in combination with plateau-form short implants. Thus this paper is intended to describe the surgical technique

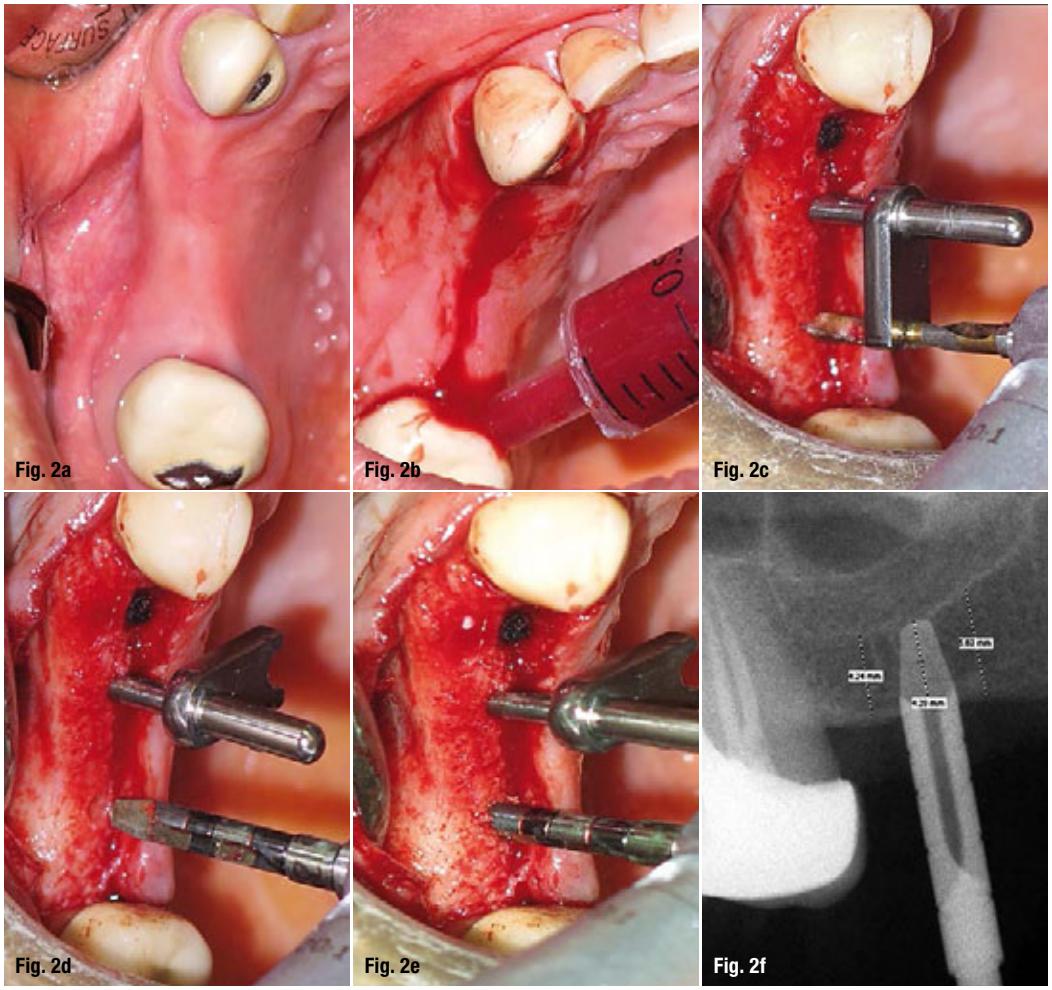

Fig. 2: Description of the surgical procedure: **a)** clinical condition of the alveolar ridge that shows the edentulous area of teeth 14, 15 and 16 prior the beginning of the surgical procedure; **b)** crestal incision and blood collection with a sterile syringe for further bone graft; **c)** pilot drilling at the site of dental implantation with simultaneous ISL; **d)** 2.5 mm latch reamer with no cutting edge to start osteotomy widening at the crestal bone; **e)** 2.5 mm latch reamer perforation in the bone starting the osseous widening; **f)** X-ray showing RBH (4.24 mm) and also 2.5 mm latch reamer insertion into the bone (4.29 mm).

of a predictable procedure we developed during our 20 years of practical hands-on training with students and course participants.

Case report

A female 58-year-old patient consulted us because of her desire of functional and aesthetic repairment. The patient did not relate any medical background of clinical interest. She also signed informed consent prior the beginning of study, held ASA I status and required dental implantation in the upper posterior maxilla with at least 4 mm on RBH and measured through a digital periapical radiograph by a single operator calibrated for this (Intraclass Correlation Coefficient: 0.83).

Amoxicillin 500 mg was prescribed to the patient two days prior the surgical procedure, once every eight hours in order to avoid infections. Surgical procedure was performed by a different trained clinician with more than 25 years of experience in the field.

Surgical Technique

Infiltrative anaesthesia was used in the procedure. Initially, a non-epinephrine anaesthesia was used (PRICANEST 4%, Ropsohn Therapeutics, Bogotá, Colombia) in order to collect blood (Fig. 2b) to mix with the grafting material (50–500 µm Synthograft, Bicon Dental Implants, Boston, USA). Then 2% Xylocaine (Dentsply Pharmaceutical, York, USA) was used to complete the surgical procedure.

Intrasulcular incision was performed by using a size 15 blade in a Bard-Parker scalpel. Full thickness flap was obtained in the area and then a previously published protocol[8] was followed to perform ISL: pilot (2 mm diameter) drilling to achieve cortical perforation was started. Pilot drilling length (1–2 mm) was determined upon residual bone height prior measurement (Fig. 1b). This high-speed 1,100 rpm drill is used with external water irrigation and has a cutting edge at the apical portion. The pilot osteotomy should be 1 to 2 mm shorter than the calculated RBH measured on the periapical xR. The following steps are achieved with latch reamers at 50 rpm without water irrigation. The reamer consists of two vertical cutting edges, which stops 2 mm before the apical portion. The apex is tapered and without a cutting edge to avoid Schneiderian membrane perforation. A 2.5 mm latch (mechanical) reamer was inserted to start the widening of the crestal cortical bone and to deepen

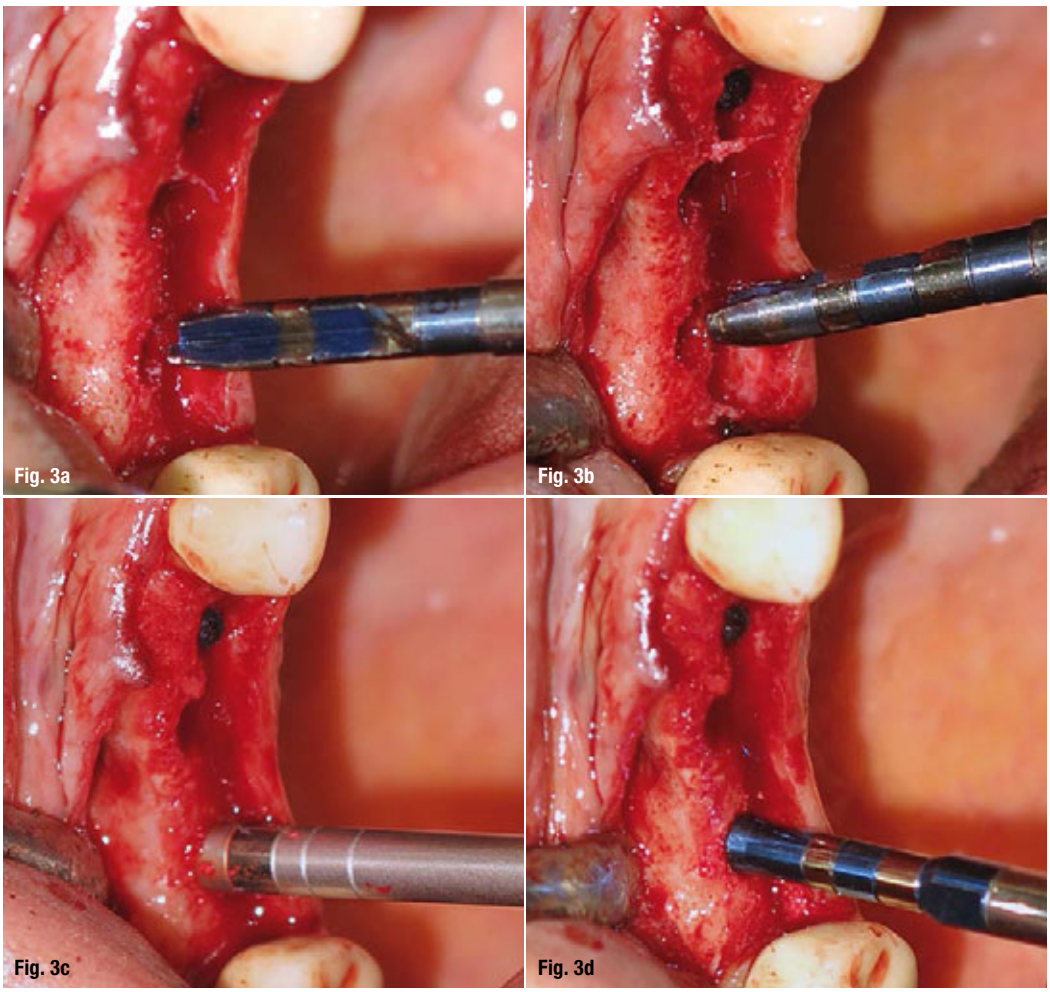

Fig. 3: Microfracture points along the cortical zone performed with the 3.5 mm hand reamer. **a)** First microfracture at distal, **b)** third microfracture at buccal and the fourth microfracture was performed at distal. **c)** Clinical picture of the grafting material being injected and **d)** the 3.5 mm osteotome first insertion into the cavity.

the bur with finger pressure towards the cortical bone of the sinus floor. The pressure allows the non-cutting edge to be pressed through the smooth cancellous bone but stops at the hard tissue of the sinus floor (Fig. 2d). With this 2.5 mm latch reamer, an X-ray was taken to determine the reaming final length before sinus floor (Fig. 2f). The RBH was measured to determine the final drilling length and the latch reamer series with 0.5 mm diameter improvement were inserted until the 4.5 mm implant diameter was reached.

The following step describes the microfracture technique of the sinus floor. With the 3.5 mm hand reamer that has a single vertical cutting edge and ends with a knife-edge at the apex of the reamer, we tapped the sharp tip of the hand reamer at four different points along the buccopalatal and mesiodistal axis to facilitate the microfracture of the sinus floor cortical bone. The first fracture point was the lowest RBH on the periapical. We started the fracture at the distal aspect of the osteotomy (Fig. 3a). The second and fourth fracture points are always the buccal (Fig. 3b) and the palatal because of their higher pneumatisation towards the buckle. The third point in this case is the mesial aspect.

A synthetic and bacteriostatic grafting material (Synthograft, β-TCP, size 50–500 γm) was mixed with the collected blood until getting a putty consistency and no liquid was obvious in the mixture. A 4.0 mm bone graft syringe was used to place a bone graft material into the apical portion of the osteotomy (Figs. 3c). Once resistance against the Schneiderian membrane was detected, a slow retraction of the syringe while continuously injecting was done. After bone graft material was injected, a 3.5 mm Summer osteotome was used to gently push the material into the osteotomy. With the graft material in place, the osteotome was advanced via gentle tapping until the cortical bone was fully fractured, and lifted with the sinus mucosa (Figs. 3d, 4a–c).

A 4.5 x 6.0 mm Implant (Bicon Dental Implants, Boston, USA) was inserted into the grafted osteotomy using first an implant inserter and retriever mounted in a straight handle and then by gently tapping with a seating tip (Figs. 4d–f).

If the remaining RBH is more than 3 mm, the first plateaus following the sloping shoulder will be engaged against the osteotomy walls and this press fit implant will not move during the healing because a

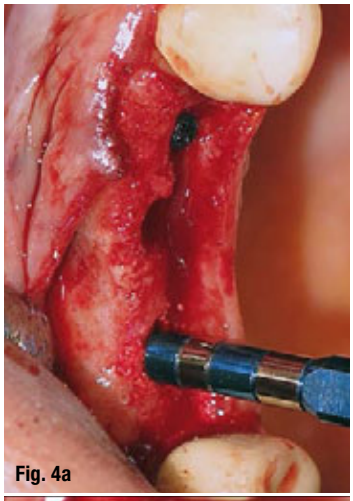
Fig. 4a

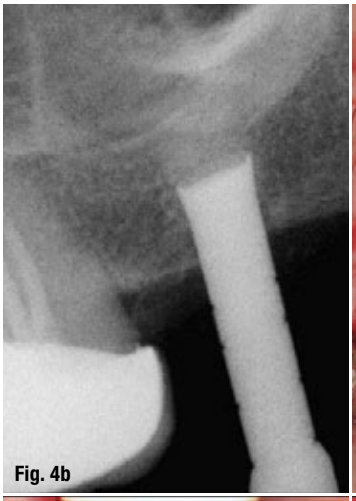
Fig. 4b

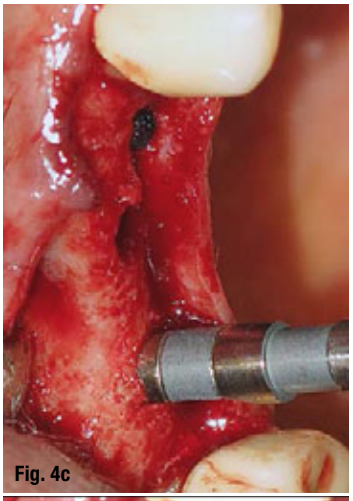
Fig. 4c

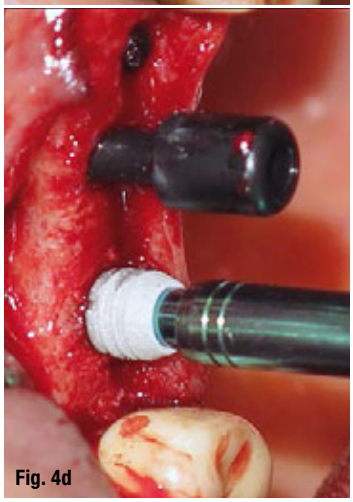
Fig. 4d

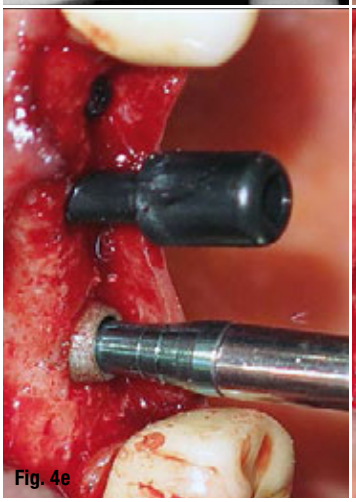
Fig. 4e

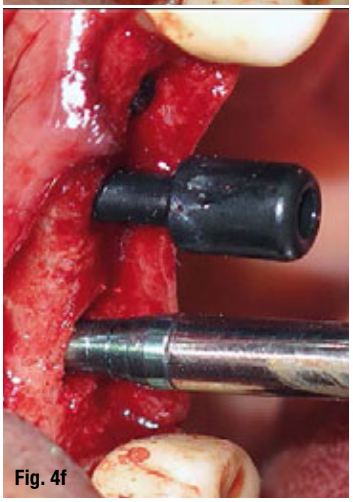
Fig. 4f

Fig. 4: a) The 3.5 mm osteotome inserted into the osteotomy pushing the material against the Schneiderian membrane; **b)** X-ray image showing the 3.5 mm osteotome position and also the grafting material; **c)** 4 mm osteotome performing the green stick fracture; **d–f)** implant insertion into the osteotomy with the straight handle and the 3 mm seating tip.

primary stability is achieved. When a RBH ≤ 3 mm is present, a sinus lift abutment (Bicon Dental Implants, Boston, USA) needs to be placed in order to avoid implant displacement into the lifted sinus. This implant design will not have a primary stability along the osteotomy walls because it is placed 2 mm under the crest and the implant body would be fully immerged into the grafting material. Plateau-formed implants with healing chambers between the plateaus do not need a primary stability but the internal sinus abutment stabilises the implant into its final prosthetic position. Single suture with polyglycolid acid (PGA) was used to close the mesial and distal relieving incisions (ACE Surgical Supply CO, Brockton, USA). After implant insertion, immediate post-op X-ray was performed (Fig. 5). The Patient received post-op instructions and homecare instructions. Antibiotics (Amoxicillin) and analgesics (Nimesulide) were prescribed to avoid infections and pain/swelling.

Discussion

Dental implantation is still the most effective approach to replace a missing tooth due to the observed survival rates over the time. However, sometimes the anatomic conditions could restrict implant positioning into the ideal space, thus limiting the prosthetic options.[9] Maxillary sinus pneumatisation occurs as the result of the upper posterior tooth loss. As a consequence, internal sinus lift (ISL) has been documented as one of the surgical approaches to accomplish implant placement in the same surgical procedure.[10] Results of this case report suggest that ISL and simultaneous implantation were successfully performed on the patient with no intraoperative or early postoperative complications.

The employment of sinus grafting in conjunction with the ISL procedure is still open to debate. According to Summers' recommendation, autogenous, allogenic or xenogenic grafting materials are often inserted into the elevated area to maintain the space for new bone formation. Moreover, several studies have suggested that the Schneiderian membrane elevation by itself promotes bone regeneration by means of the formation of a fibrin clot in the created space. This clot, which is stabilised and protected from external trauma and intra-sinus pressure, would have the potential to stimulate bone formation.[11,12] However, this option is highly susceptible to membrane perforation or membrane invagination around the implant apex.

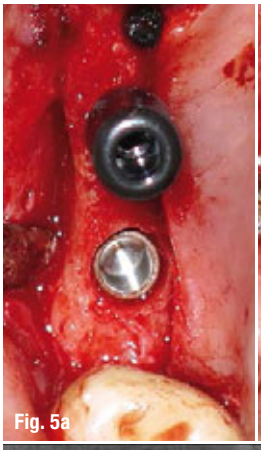
Fig. 5a

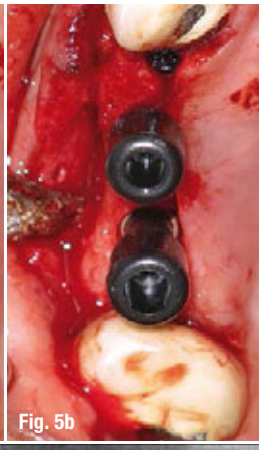
Fig. 5b

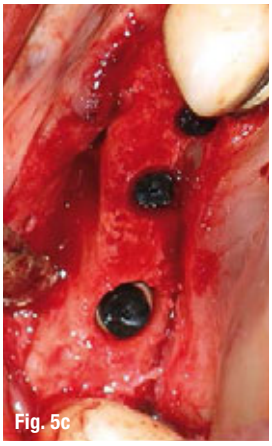
Fig. 5c

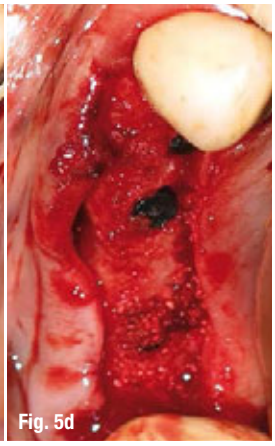
Fig. 5d

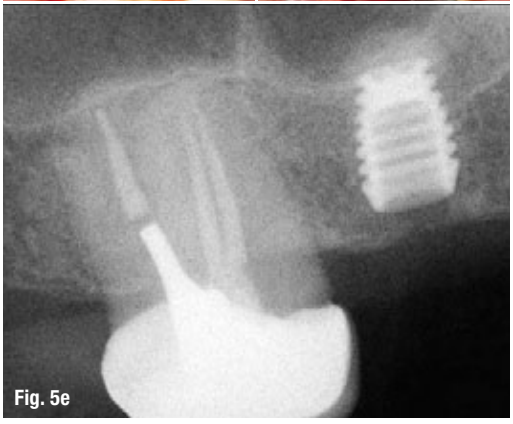
Fig. 5e

Fig. 5: a) Clinical picture showing the implant position after its placement via gentle tapping; **b)** placed implant with the healing plug; **c)** cutted view of the healing plug for the placed implants in the zone; **d)** autologous bone graft over the implant with the collected bone during the osteotomy; **e)** immediate final X-ray views of the placed implant together the internal sinus lifts procedure. On the apical portion of the implant the grafting material is observable.

We then decided to use pure-phase tricalcium phosphate, a synthetic material into the created space to avoid the collapse of the Schneiderian membrane around the internal sinus implant portion and promote bone formation during the osseointegration period also around the implant apex.

Associated complications with the sinus augmentation procedures are well described in the literature. The most common complication is membrane perforation during procedure and its prevalence is between 7 and 44 %. Haemorrhage, infection and rhinosinusitis are also described as expected complications.[13] However, none of them were present in our patient, indicating an immediately successful surgical procedure which was specially developed for clinicians with no experience in sinus lift elevation.

Implant survival placed in conjunction with ISL has been also well reported in the literature ranging from 94 % to 100 %.[14,15] Nevertheless, the most critical issue is the crestal bone level maintenance over the time. This is achieved by placing the implant in a subcrestal (submerged) fashion and by the usage of an implant with convergent crest module, represented by the sloping shoulder geometry, which enhances the platform switching (PS) to occur. This PS allows an increase in residual crestal alveolar bone volume around the neck of the implant, repositions the papilla to a more aesthetic and apposite level, reduces mechanical stress in the crestal alveolar bone area and assists in enhancing the vascular supply to hard- and soft-tissue in case of reduced interdental space.[16,17]

ISL is reliable if used with the proper protocol, less time consuming procedure, with lower rates of complications that can be considered in patients with upper posterior decreased alveolar ridge. In a non-traumatic way and during the same surgical procedure it allows implant placement with no immediate complications during the procedure nor a short postoperative time period._

Conflict of interest statement: Authors declare they do not have any conflict of interest.

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Author details

Literature

contact

Miguel Simancas Pallares
Avenue Del Consulado 48-152
University of Cartagena
Health Sciences Campus
Faculty of Dentistry, Research Department, Suite 301
Cra. 6 #36, Cartagena, Bolívar, Colombia
Tel.: +57 5 6698172-110
msimancasp@unicartagena.edu.co